The Royal Aeronautical Society

(FOUNDED 1866)

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PROCEEDINGS

FIFTH MEETING, SECOND HALF, 65TH SESSION

The Fifth Meeting of the second half of the 65th Session of the Society was held in the Lecture Hall of the Institution of Electrical Engineers, on Wednesday evening, February 19th, when a lecture on " Gliding " was delivered by Dr. Georgii and Herr Stamer.

The chair was taken by Colonel the Master of Sempill, A.F.C., A.F.R.Ae.S. (President).

The PRESIDENT: The Society was honoured that evening by the presence of two distinguished visitors, Dr. Georgii and Herr Stamer, who had specially come over from Germany to lecture to the Society. Dr. Georgii had come from Darmstadt, where he was Professor of Meteorology, and Herr Stamer was the Director of the largest gliding school in the world.

Dr. Georgii was a Doctor of Science of Jena. Before the war he had specialised in meteorology in which he was a well known international figure. After the war he took up the position of Professor of Meteorology in the University of Frankfort, where he remained until 1924. Then he went to Hamburg, to the Marine University there, where he occupied a similar position, and subsequently he went on from there to Darmstadt. He had been at Darmstadt for several years as professor in charge of the meteorological work, and he was also the director of a private organisation, receiving a State subsidy, which dealt with all questions in connection with gliding in Germany. The research department of that organisation was divided into three sections, namely, aerodynamic, technical and meteorological, and Dr. Georgii was responsible for that particular work. Dr. Georgii's first interest in gliding began ten years ago, and that evening he would give them the result of ten years of his experience. He started on the subject mainly from the point of view of meteorological interest. He had organised a series of gliding competitions, the first of which took place in 1920. These few particulars of his career would show what a wealth of experience he brought to bear on this subject.

Herr Stamer was the director of gliding and soaring at the school on the Wasserkuppe on the Rhone. He took up that position ten years ago, and he was without question the acknowledged expert on gliding and soaring flight in Germany to-day. In 1914 he was training as an architect, and he gave that up and went into the Infantry, exchanging in the following year into the military branch of the German Flying Corps. About two years later he was shot down, and remained a prisoner of war until the cessation of hostilities. Shortly after going back to Germany he was appointed director of the school at Wasserkuppe. His technical experience and his experience of training people for this form of sport were quite unrivalled.

The President added that he did not propose to give the Society any history of gliding or of the progress which had taken place in this subject in this and other countries. There were present in the audience many founder members of the institution which had just been formed in this country, the British Gliding Association, the birth of which had been of great interest to their two German visitors. In 1922 the *Daily Mail* contest led to the production of the light aeroplane as it was known to-day. In Germany the results were quite different, and there the development of the glider led to the development of the sailing machine, or, as it was called in England, the soaring machine. The experience which the Germans had had with these machines, under the direction of Dr. Georgii, would furnish one of the most interesting phases of his lecture. When it was considered that in Germany there were about six schools for the training of pilots of gliding and soaring flight, and very nearly 100 clubs, about 200 gliding machines, and something like 60 soaring machines, it could be gathered what a tremendous movement had taken place. There were actually 3,000 pilots in Germany licensed to operate gliders. Of these 3,000, only about 2,000 had qualified for their " B " license, and only 300 for their " C " license, which was the soaring license.

The importance of gliding, he thought, could not well be over-estimated. It had a great importance from the educational standpoint, from the standpoint of the development of the power-driven machine, and also it had several important aspects from the point of view of the Royal Air Force, who, if they studied carefully the experiences of these gentlemen and their confreres in Germany, would be able to learn a great deal as to the efficient operation of machines under war conditions which they would find rather surprising.

Dr. Georgii was not a great student of English, and he asked to be excused from reading his paper in full. Major Low, who had translated the papers of both Dr. Georgii and Herr Stamer, would read them both, after which Dr. Georgii would show a film.

Dr. GEORGII: He regarded this invitation from the Royal Aeronautical Society as a very great honour, in which all his German confrères shared, and he thanked the President and Council for giving him the opportunity of speaking to a British audience on this development of motorless flight. His knowledge of English was too limited to warrant any attempt to deliver the lecture himself, and he greatly regretted this, because he would have liked to have put forward to the audience something of the significance and the beauty of this pursuit. But he hoped that the evening would be of importance for the cause of motorless flight in Great Britain. If motorless flight was to develop and to realise its possibilities in various parts of the globe, it was necessary to have international co-operation. At all times sport and science had brought the nations together in peaceful alliance. Both sport and science were being cultivated in motorless flight in such close co-operation as was not usually seen in other spheres. From this angle he would like to express a hope that British flying men would join in the efforts which were now being made with a view to opening up the realm of motorless flying.

TEN YEARS' GLIDING AND SOARING IN GERMANY

BY

PROFESSOR DR. WALTER GEORGII OF DARMSTADT

MR. CHAIRMAN, LADIES AND GENTLEMEN:—

Before passing to the subject of the paper may I ask your indulgence for my limited knowledge of English, which prevents my giving a free discourse, and constrains me to a set lecture. This I view with regret since it makes it difficult to impart to my words the lively and vivid feeling which a more formal picture of the importance and attractiveness of gliding flight may not give.

We are looking back on ten years of development and on an unbroken series of ten gliding competitions held at the Wasserkuppe in the Rhön, since 1920.

The organisation has not only maintained its range of activities all these years but has largely extended it, and in this way has given the best proof of its vitality and purpose.

In the first decade, now completed, successes have been achieved such as few foresaw, and the cause may be sought in the spirit of close co-operation with which the sportsman strove to avail himself of the flying possibilities opened up by the scientist.

This union of sport and science is in the true tradition of German gliding since its revival in 1920. At Frankfort in that year, Oskar Ursinus directed the "air-minded" members of the younger generation towards gliding as a substitute for power flight of which they were perforce deprived; but he had the progress of aeronautical science at least as much at heart as the interest of the sport. He desired to direct aeronautical investigation along a new path, and to free it from the restricted view that progress was bound up with power flight. Were it possible to develop gliders carrying appreciable loads, they would serve as prototypes for

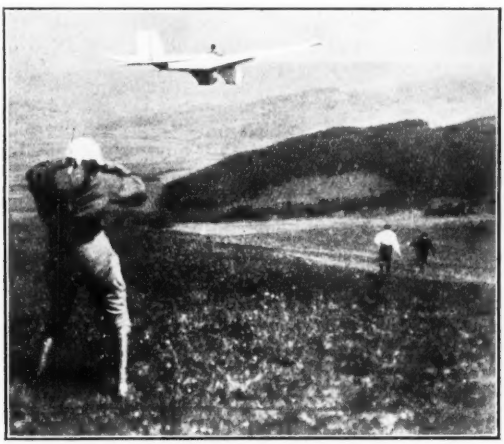

FIG. 1.

Klemperer's sailing aircraft, 1920.

light aeroplanes, without losing sight of more general sporting possibilities. The evolution of the light sporting aeroplane from the glider was his technical objective. His sporting aim was to offer keen youngsters a chance of flying at no great financial outlay by giving their time freely to constructing gliders. In the course of their purely sporting activities they would develop a sound team spirit and would find a stimulus to technical and scientific work.

On his initiative the first gliding competition at the Wasserkuppe in the Rhön was held in August, 1920. In spite of initial difficulties a new gliding record of 2 minutes 22 seconds and 1,830 metres, was made by W. Klemperer, whose design first settled the type of construction suitable for gliders. It was a cantilever low-wing monoplane, in which great care was given to keep down resistance with its adverse effect on performance (Fig. 1).

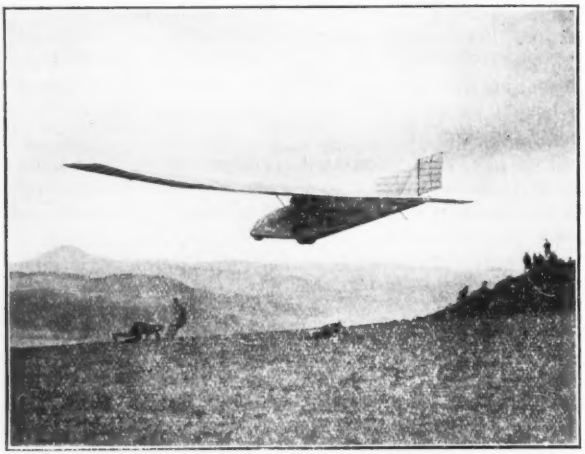

FIG. 2.
Vampyr gliding, 1921.

In the following year the same principle of keeping down body resistance was more fully applied by G. Madelung to his glider "Vampyr." The "Vampyr" type prevails at the present time, and this is a measure of Madelung's contribution to glider design.

Since gliding flight depends on the use of slowly rising currents in the air, a practicable glider is chiefly characterised by a small vertical component of velocity, or rate of descent.

A small rate of descent may be obtained either by reducing the sum of the resistances or by reducing the wing loading. These two methods have been applied, and lead to two special types of glider, both of which find application for special purposes. A large span and good aspect ratio are favourable to a small (induced) resistance, and further reduction of resistance is gained by a closed body, cantilever construction (no external bracing) and by dropping the starting carriage.

From the "Vampyr," the prototype of German high performance gliders, onwards, all these methods of reducing resistance have been so carefully studied and carried out that further fundamental improvements are scarcely to be expected.

The photographs, Figs. 2, 3, 4 and 5, show the best known German high performance gliders from the " Vampyr " of 1921 to the " Wien " of 1929.

" Vampyr "—Academical Flying Club of Hanover, 1921.
" Consul "—Academical Flying Club of Darmstadt, 1923.
" München "—Academical Flying Club of Munich, 1928.
" Wien "—R. Kronfeld. Built by A. Lippisch, 1929.

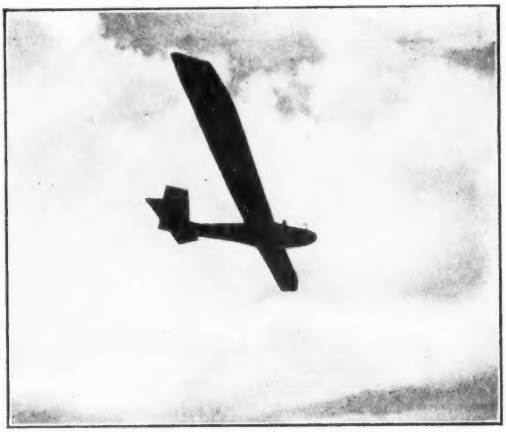

FIG. 3.
Sailing aircraft " Consul " of the Darmstadt Academic Flying Group, 1923.

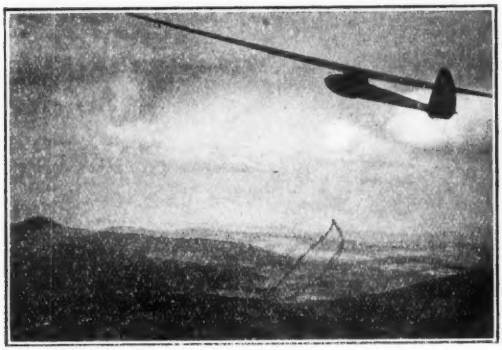

FIG. 4.
Sailing aircraft " München " of the Munich University Flying Group, 1928.

On the " Wien," Kronfeld carried out his great duration flights, covering distances up to 150 km.

In designing for low head resistance the structural weight is increased to a restricted degree, and the structural methods, illustrated above, produce medium

heavy gliders with a margin of strength for high performance and for flying in gusty weather. The additional weight gives the greater air speed required for progress against strong winds and for passing rapidly through unfavourable belts of down wind.

The glider of low resistance and considerable structural weight is the best all round for long cross-country glides by virtue of its slow descent and high air speed.

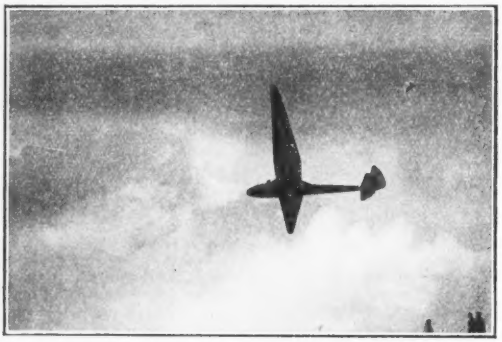

FIG. 5.
Sailing aircraft "Wien," R. Kronfeld's aircraft, constructed by A. Lippisch, 1929.

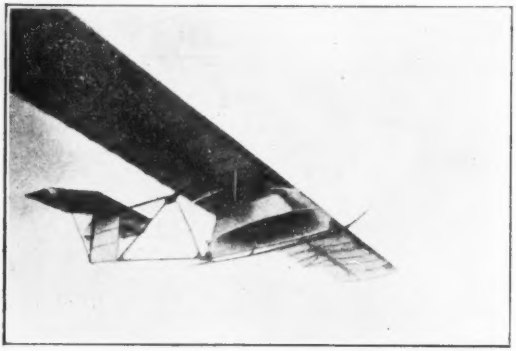

FIG. 6.
Anamma.

Another method of reducing the rate of descent, by reducing the wing loading, is widely applied to glider design but is quite unsuitable for high performance. It produces a very special type of low air speed, poor gliding angle, light structural weight and simple form.

The Djalvar—"Anamma" ("Devil take it") is of this type and its main characteristics are: braced monoplane wings, single girder, tail boom, and boat-shaped cockpit below the wings. Fig. 6 shows a standard glider of this type.

It has a good duration performance in light winds but a restricted range on account of its slow air speed. In the school type the aerodynamical qualities are sacrificed to more robust construction, simplified for ease of repair; the cockpit is not covered so that the pilot may fall clear in a smash, and restricted gliding and soaring powers are desirable for training purposes. The best known of this derived type is the Zögling " (Fig. 7).

Once the principles of successful soaring were recognised results soon followed.

In 1922, Hentzen and Martens, both students, carried out the first soaring flights, lasting over an hour, on the " Vampyr." Hentzen's record flight of three hours ten minutes, attaining an altitude of 350m., made the activities at the Wasserkuppe world-famous. It elucidated the problem of soaring flight by using the energy in the air's motion.

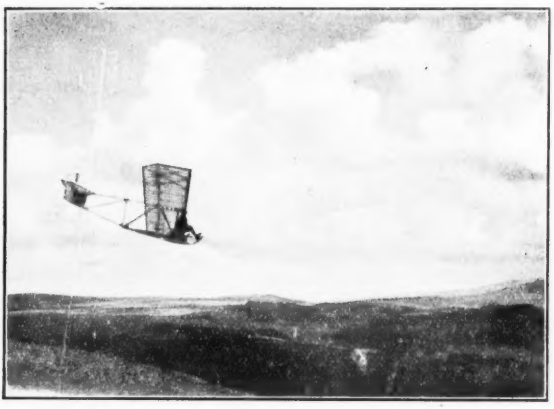

FIG. 7.
Instructional glider " Zögling " of the Rhön-Rossitten Co., 1926.

In accordance with the laws of motion soaring is possible in an ascending current of air, and in a horizontal air current of variable velocity. When the rate of ascent of the air current equals or exceeds the rate of descent of the slides " static soaring " is possible.

When the horizontal wind is variable, the pilot gains height as the velocity increases and loses height as the velocity decreases. As the air forces are proportional to the square of the air speed, it is possible in principle to obtain a net gain. If the net rate of gain equals or exceeds the rate of descent, " dynamic flight " becomes possible. It is quite probable that some dynamic gain was obtained in the earlier flights, but not by any systematic use of the wind fluctuations.

The extensive efforts made from 1921 to 1923 to connect pulsating dynamical effects with the performance of man-carrying gliders did more harm than good to the development and reputation of soaring, the possibilities of which, apart from any such effects, have been fully shown by the subsequent years.

To revert to static soaring, local rising currents are produced by every irregularity of the earth's surface—knolls, dunes, woods, the waves of the sea—and may be utilised for soaring flight.

The photographs, Figs. 8-11, show well-known soaring grounds:—

The Wasserkuppe in the Rhön (Figs. 1 and 9).
The French soaring grounds at Vauville (Fig. 13).
The soaring grounds at Rossitten on the Kurisch lagoon (at the mouth of the Memel in East Prussia) (Fig. 10).

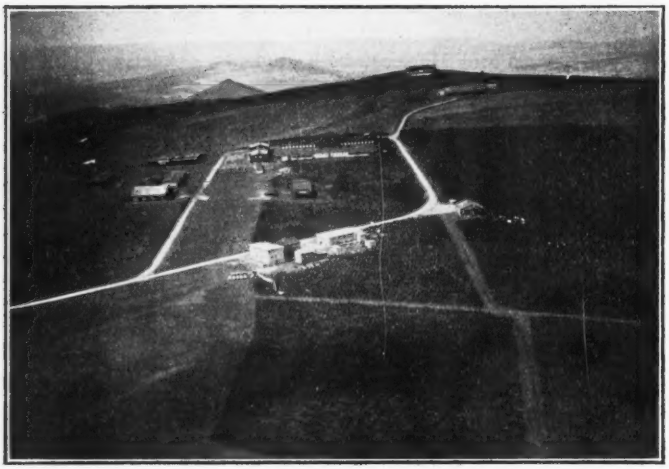

FIG. 8.
Soaring grounds and flying station on the Wasserkuppe in the Rhön.

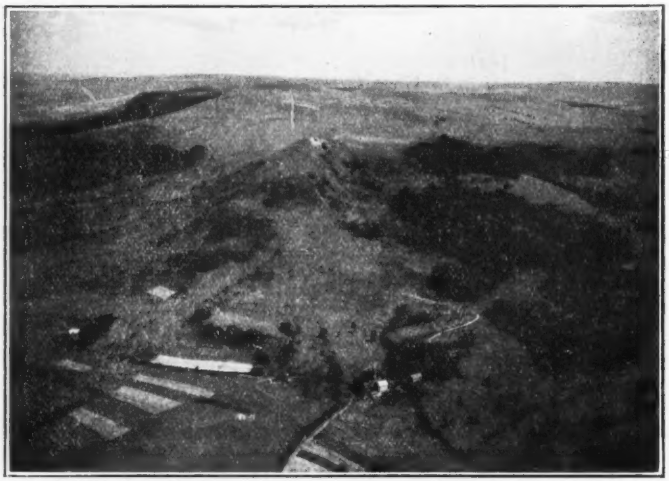

FIG. 9.
Western declivity of the Wasserkuppe, Rhön.
(Main sailing-flight declivity.)

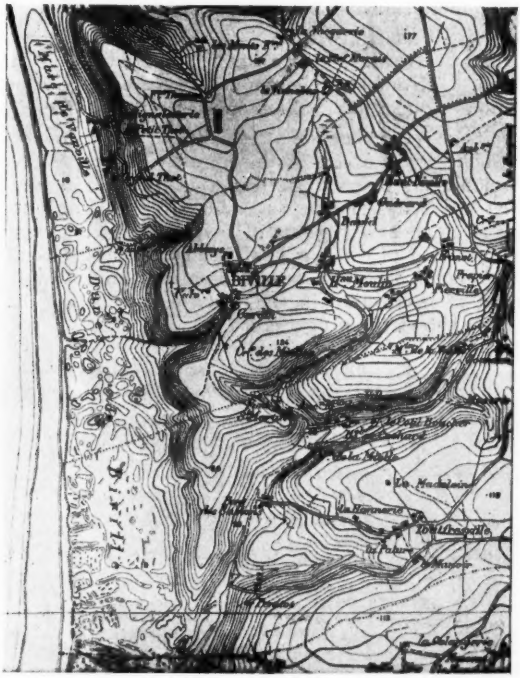

FIG. 10.
French soaring grounds near Vauville.

FIG. 11.
Gliding ground at Rossitten from the Nehrung.

The following table shows a number of duration records.

	Wasserkuppe			Rossitten.		
Year	1922.	1928.	1929.	1924.	1925.	1929.
Pilot	Heutzen.	Kronfeld.	Neininger.	Schulz.	Schulz.	Dinort.
Duration	3h. 10m.	7h. 24m.	8h. 24m.	8h. 24m.	14h. 7m.	14h. 43m.

It is seen that the records at the Wasserkuppe have dropped far behind those at Rossitten. Such flights are a useful stimulus to the sport but do not much help further developments of soaring. For this reason cross-country flights have been preferred at the Wasserkuppe as eminently serviceable for research work, and by this means alone new regions of favourable rising winds have been delimited, and the practice of soaring has been made less dependent on time and place. The performance has been steadily improved and a high aeronautical and scientific standard of instruction in the methods of soaring has been attained. The following table shows the progress made since 1922.

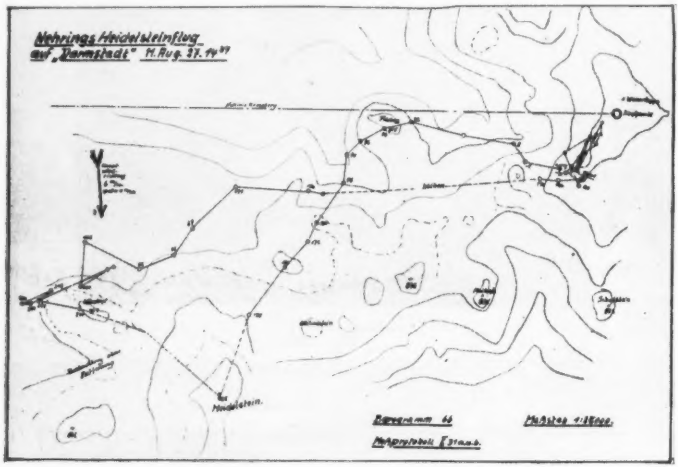

Fig. 12.

Heidelstein flight by Nehring on the sailing aircraft "Darmstadt," August 11th, 1927.

Cross Country Soaring Flights

Year	Pilot	Distance in km.	District
1922	Martens	9.5	Wasserkuppe
1923	Botsch	19	,,
1925	Nehring	21	,,
1927	Nehring	52	,,
1928	Schulz	62	Rossitten
1929	Nehring	72.3	Odenwald
1929	Kronfeld	100	Teutoburger Wald

The technique of cross-country soaring flights is best shown by plotting the course on a contour map, with barogram readings of the heights attained, and other information supplied by the pilot. The two examples selected are the masterly flights of Nehring on the Darmstadt and Hirth on the Lore, from the starting point round a fixed mark and back.

In the flight round the Heidelstein (Figs. 12-14), Nehring first soared over the south slope of the Wasserkuppe until he had gained 150m. height above the starting point. He then flew parallel to the ridge and at right angles to the

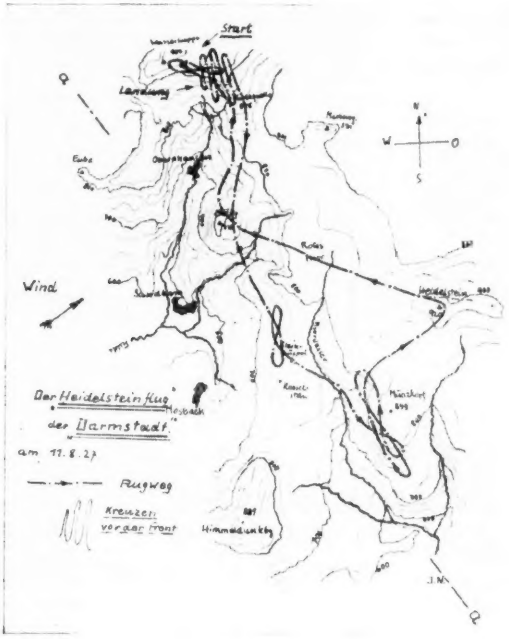

FIG. 13.
Heidelstein flight by Nehring on the sailing aircraft "Darmstadt," August 11th, 1927. Plan of the course of flight.

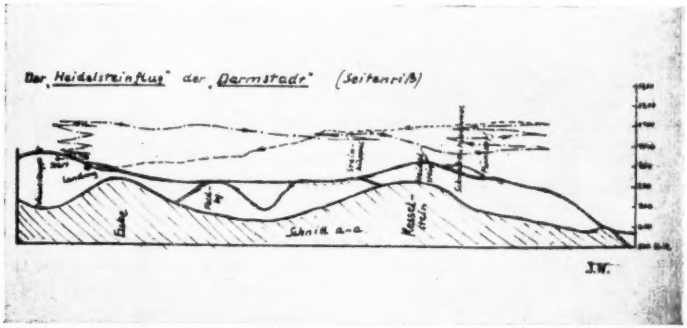

FIG. 14.
Heidelstein flight by Nehring on the sailing aircraft "Darmstadt," August 11th, 1927.

prevailing wind to Münzkopf, where he used the strong up-current to reach his maximum height at 260m., which was sufficient to reach the Heidelstein and return to the starting point.

Hirth's flight was more difficult and more instructive (Fig. 15). He started from the west slope of the Wasserkuppe, and maintained himself there until he had gained 400m. in height, and then carried out his cross-country flight to the immediate neighbourhood of the Schweinsberg without serious difficulty. On

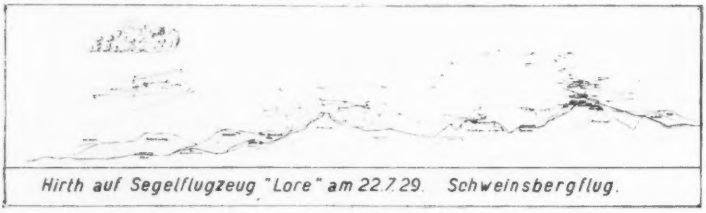

FIG. 15.

Schweinsberg flight by Hirth on the sailing aircraft "Lore," July, 1929.

the return flight he found that he had lost height badly and was 200m. below the starting point. He was twice forced to turn back and soar over valleys with up-winds in order to regain sufficient height to regain the western slope, over which he cruised until he was high enough to land on the plateau of the Wasserkuppe at the prescribed point.

In this admirable exhibition of the methods of cross-country work, it is seen that the pilot leaves the original region and seeks new areas of rising wind, leaving nothing to chance, but laying his course beforehand, according to the wind prevailing and to the lie of the land. It is characteristic of such flights that

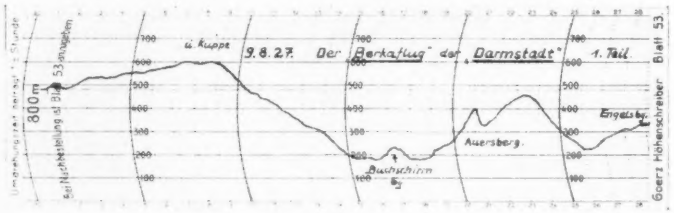

FIG. 16A.

Barogram of the flight from Nehring to Berka, August 9th, 1927.

the best course is not in general the shortest distance, but may involve long detours in reaching up-wind areas, and lengthy soaring over a particular point in gaining sufficient height. Briefly, the pilot must fly on sound topographical and meteorological information, if he is to reach his goal. Cross-country flights will be achieved over wide regions by flying from slope to slope, from hill to hill, and finally, from range to range. The satisfaction of skilfully adapting soaring flight to the configuration of wind currents and landscape is enhanced if need be by the sporting excitement and by the real value to flying.

Nehring's flight of August 9th, 1927, is another instructive example of cross-country work in which a whole range was transversed by passing from hill to hill. There was no straightforward continuous region of upwinds available. Local areas of rising wind had to be sought out on slopes facing the general direction of the wind, and wide belts of downwind lying between them had to be crossed. The masterly fashion in which Nehring carried out these successive stages is shown by the next two slides.

A barogram of Nehring's 53 km. flight to Berka, August, 1927, is shown in Fig. 16 and a plan and height contour of the same flight in Fig. 17.

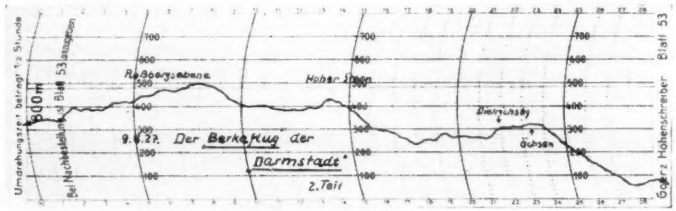

FIG. 16B.

Barogram of the flight from Nehring to Berka, August, 1927.

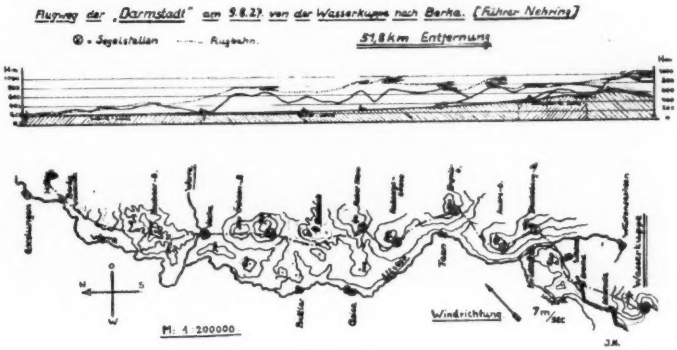
Flugweg der „Darmstadt" am 9.8.27 von der Wasserkuppe nach Berka. (Führer Nehring)
51,8 km Entfernung
Windrichtung
7 m/sec
M. 1:200000

FIG. 17.

Vertical section and plan of the course of the flight by Nehring to Buka. Distance flown 53 kilos., August, 1927.

The ups and downs of the barogram correspond to the up and down wind regions which were met. The plan of the course shows very well the flying tactics adopted in circling over hills which produced rising winds, long enough to gain extra height for the next stage of the flight.

Kronfeld's 100 km. flight in Spring, 1929, over the Teutoburgerwald was achieved by these same tactics, and supports the view that a sound knowledge of the flow of the wind round hill ranges, hills, knolls and dunes enables a soaring pilot, competent in his art, to achieve remarkable cross-country performances, over hill and dale.

We cannot remain content to restrict soaring to hilly country but must strive to bring within its scope the regions of the air above flat lands. The sailing

flight of birds, indeed, shows that upwinds exist over plains, and are probably adaptable to soaring man-flight.

Research on soaring was initiated just at the beginning of the serious crisis of 1924 and 1925.

Soaring gliders had not been involved in the restrictions imposed on power aircraft, but were adversely affected by the revival of interest in the sporting possibilities left open to light aeroplanes, when the worst restrictions were removed.

After the record duration soaring flights of 1922 England, France, Italy and Russia had held soaring competitions, but interest had soon passed back to the light aeroplane. Even in Germany soaring came to be regarded as a mere makeshift for power gliding. Only when this erroneous view had been disproved, and soaring shown to have its own individual scope, did the crisis pass.

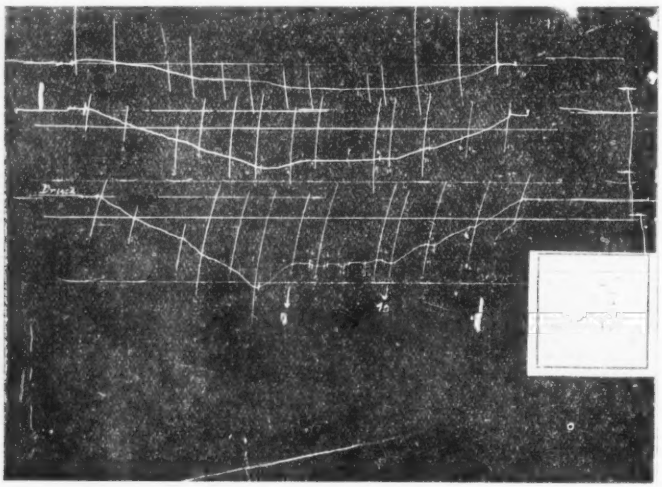

FIG. 18.

Barogram of the exploration flight of 30th April, 1928.

The Rhön Rossitten Gesellschaft was founded in these difficult times, with the purpose of supporting gliding schools, of holding competitions to give publicity, of improving performance, and of stimulating gliding activities generally. A special research department was established at the Wasserkuppe for advancing technical and scientific knowledge of the problems involved, and the management was placed in the hands of the present author in 1926.

The Rhön Rossitten Gesellschaft may be regarded as the centre of the gliding movement in Germany and in other countries. Teams were sent to the meetings in the Crimea at Asiago and at Vauville. Instructors were sent to the United States on the formation of the American gliding school at Cape Cod. A French educational commission has received full training, and this has stimulated the sport in France. Technical advice has been given to Hungary, Holland and Belgium. In these ways the Society has made its contribution to the common problem of soaring flight to which in turn all other nations can contribute their activities. Since 1926, having overcome the crisis of 1924-25, the practice of

soaring and gliding has made vigorous and continuous progress. Glider schools have been established, and standard gliders have been distributed along with working drawings and instructions for building them. These include the "Zögling," "Prüfling" and "Professor" types. The number of airminded youngsters and their interest in gliding have been increased by these measures, and, above all, research has opened out new possibilities and has contradicted the prevailing belief that soaring depends entirely on the use of rising current over hill slopes.

The investigations of rising currents in the free atmosphere carried out in the last few years at Darmstadt and at the Wasserkuppe have shown that soaring under cumulus clouds and near cold fronts is practicable, both entirely new conditions.

It has long been known that cumulus clouds are associated with rising currents of air, but few measurements were available. Research was directed to the determination of these currents in the Spring of 1928 from measurements of the vertical rate of a power plane gliding beneath a cumulus cloud with its airscrew stopped. Repeated glides of as long as 10 minutes without loss of height were obtained.

Fig. 18 shows a barogram of an exploration flight, April 30th, 1928, and it is seen that there was no loss of height from point 7 to point 10 of the barogram, which implies a rising current of 2 m./sec.

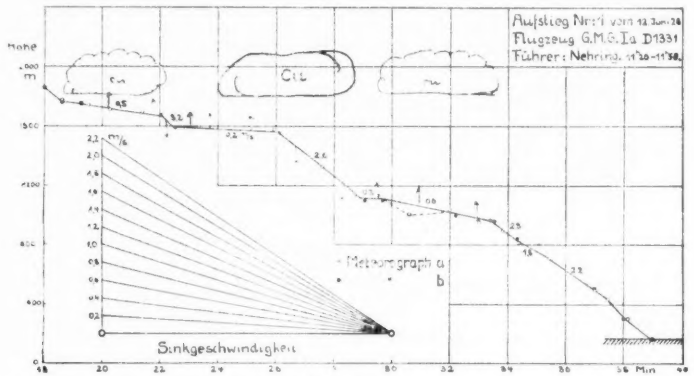

FIG. 19.

Exploration flight of the 12th June, 1928.

Fig. 19 shows a reduction of experimental flight measurements in a rising current, June 12th, 1928, giving the observed descent in a glide. From this is subtracted the known rate of descent in still air, about 1.9 m./sec. The difference measures the vertical motion of the air.

From time 20 min. to time 28 min. there is a rising current of from 1 m./sec. to 2 m./sec., and from 28 min. to 30 min. of 2 m./sec. to 5 m./sec. These are hign values and give excellent conditions for soaring in gliders, which have rates of descent as low as 0.7 m./sec.

A reduction of rising current measurements before a line squall, June 26th, 1928, is shown in Fig. 20.

A "cold front" produced a line squall of moderate intensity, and the aeroplane, with airscrew stopped, maintained itself without loss of height for 15 min. From these results it was inferred that a soaring glider starting from

the Wasserkuppe could reach the region of rising currents under a cumulus cloud or the front of an approaching squall, and this was successfully accomplished.

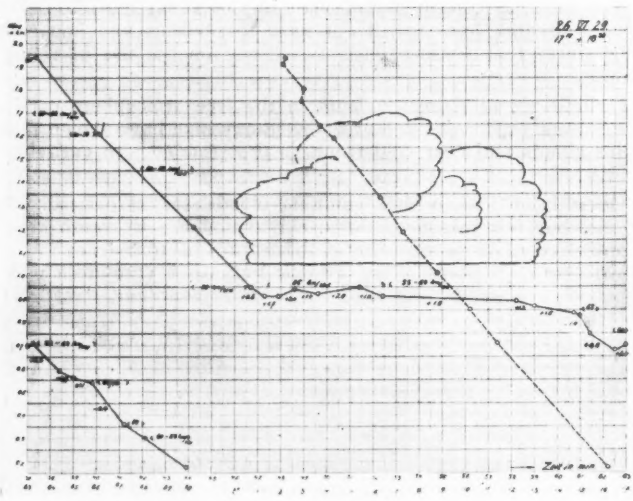

FIG. 20.

Reduction of measurements in front of a line squall.

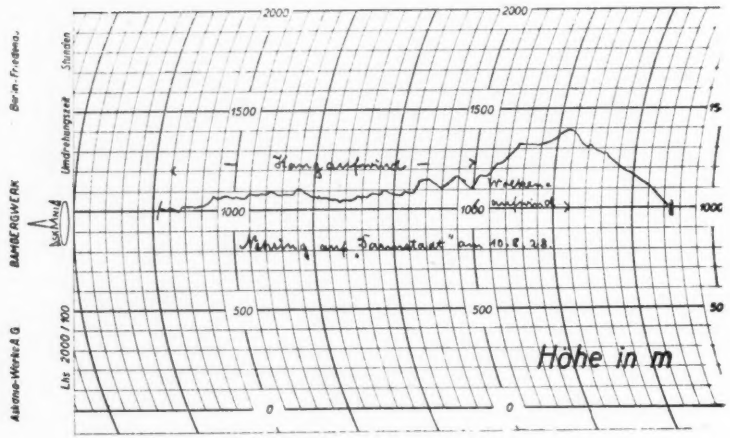

FIG. 21.

Barogram of the "Darmstadt" of the 10th August, 1928.

A barogram of soaring flight by the "Darmstadt," August 10th, 1928 (Fig. 21), shows clearly the vigorous effect of the rising current under a cloud in comparison with that produced by a hill barrier.

The " Darmstadt " maintained itself over the west slope of the Wasserkuppe at 100 m. above the starting point. In 20 min. the boundary of the up current below an approaching cloud was reached, and the glider was quickly carried up to a height of 400 m.

Fig. 22 shows a record of Kronfeld's flight at the Himmeldankberg, August, 1928.

The plan of the course is shown in full line under the cloud, in dotted line outside their influence.

Kronfeld started from the western slope of the Wasserkuppe, and flew at once towards an approaching cumulus cloud, which he followed towards the east with continual gain of height, reaching finally 470 m. above the starting point. The cloud began to dissipate and the up current became ineffective, so that Kronfeld left it and flew with considerable loss of height to the Himmeldankberg

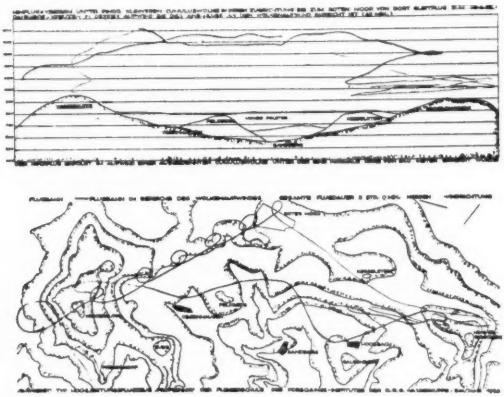

FIG. 22.

The Himmeldankberg flight by R. Kronfeld.

as pre-arranged, and there soared for some time in the up currents. On the approach of another cumulus cloud Kronfeld used it to gain considerable height, and then flying always from cloud to cloud he reached the Wasserkuppe at his maximum height of 540 m. above the starting point.

These details illustrate the difference between hill and cloud flying, between flying from hill to hill over a course, which must be adjusted to the contours of the ground, and flying from cloud to cloud over hill and plain, when the ground is ignored and the pilot scans the cloud formations and adjusts his course to their motion.

Fig. 23 gives a barogram of Groenhoff's flight with a passenger on the two-seater " Rhonadler," July 30th, 1929, and shows the extended performance obtained by flying into the cloud instead of soaring below it. Groenhoff started from the west slope of the Wasserkuppe and soared over it for a short time, then flew under a cumulus cloud and rose through it almost to its summit, reaching a maximum height of 1,250 m. above the starting point, and covering a course of 33.3 km., both figures being records for soaring flight with a passenger.

The rate of descent of the glider in still air was 1.1 m./sec., from which the vigour of the up winds may be inferred.

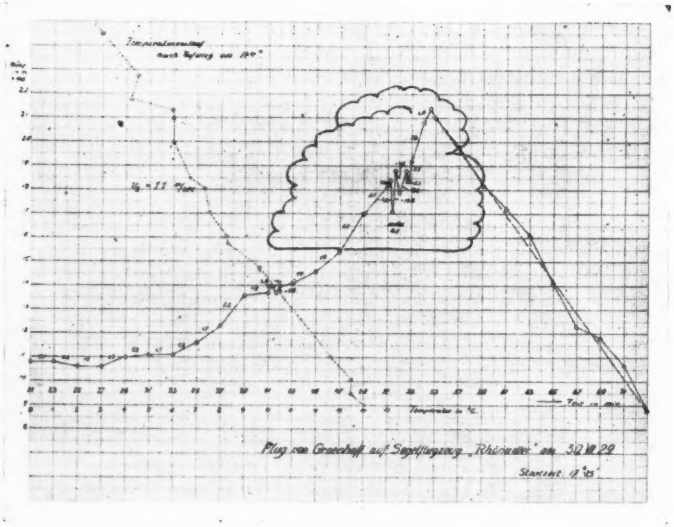

FIG. 23.
Barogram curve of the flight by Groenhoff with a passenger on the 30th July, 1929.

FIG. 24.
The 150 kilometre flight by Kronfeld from the Wasserkuppe to Bayreuth, August, 1929.

Severe vertical gusts were met with in the cloud. At 1,800 m. the glider was driven down 140 m. in a few seconds and immediately after it was carried up 170 m. Two more such gusts followed after. The chart shows a down current of 9 m./sec. and an up current of 10 m./sec.

On the same day and under the same weather conditions Kronfeld made his great cross-country flight of 150 km. from the Wasserkuppe to Bayreuth (150 km.) (Fig. 24).

Immediately after the start Kronfeld flew under a cumulus cloud and was carried up continuously to a height 2,150 m. above the starting point.

The up current given by the measurements was 5 m./sec.

After leaving the cloud height was slowly lost in passing over flat country. In two hours the Thuringenwald was reached, and the flight was continued for 4 hours in the rising currents from the ridges. Finally a landing was made at the Fichtelgebirge 150 km. from the Wasserkuppe.

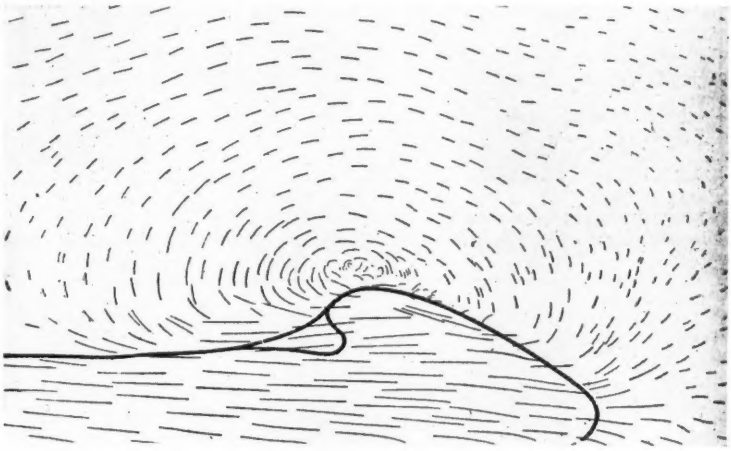

FIG. 25.

Movement of the air at a cold front into warmer masses, according to W. Schmidt.

This masterly flight is a fine example of the art of soaring, and illustrates the manner of utilising the various means available. In particular a record height in this manner was gained in the up current of a cumulus cloud formation sufficient to cross flat and hilly country alike, independently of the consideration of the surface.

The most important result is the ease with which great heights can be reached in the up currents of cumulus cloud formations. The second part of the flight gives fresh evidence of the value of the older established method of flying in the up currents from hills.

A more recent development of cloud flying is the use of up currents at the cold air fronts of line squalls, of which measurements with an engined aeroplane have been referred to. In this type of atmospheric disturbance masses of warm air are pushed up by the inrush of cold air along the surface of the earth.

Fig. 25 shows motion of the air caused by cold air flowing in under warm air (W. Schmidt), the lines of flow giving the local direction of the wind. In

front of the line squall the air rises almost vertically and offers the best soaring region.

Fig. 26 shows Kronfeld's flight in front of a line squall (143 km.) and the time changes in the line squall along the course.

FIG. 26.
Kronfeld's flight of 143 kilometres showing the advance of the storm front.

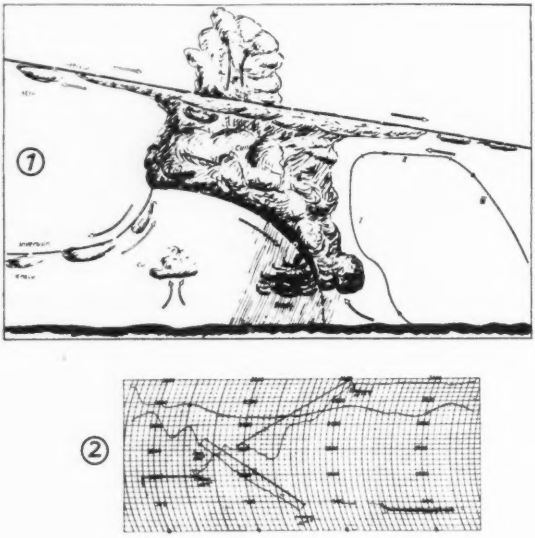

FIG. 27.
Flight by Kronfeld of 143 kilometres before a line squall.
(1) *Squall front and path of flight.*
(2) *Barogram.*

Fig. 27 (1) shows the region of up-currents before the cold front and Fig. 27 (2) the barogram of the flight.

Kronfeld started at the moment when the wind was freshening, just before the passage of the line squall, and by utilising the rising currents before the cold front rose 2,000 m. above the starting point. The middle part of the barogram shows that he then maintained steady flight.

The meteorological records determine the motion of the storm accurately, and in conjunction with the pilot's account lead to the conclusion that he flew about 2 km. before the front of the squall, rising or falling slightly as he was nearer or farther.

FIG. 28.
Towed-flight on the Wasserkuppe.

After turning away from the front the glider rapidly lost height and landed 143 km. from the Wasserkuppe after 4½ hours flight.

The knowledge gained as to the configuration of line squalls, leads to the conclusion that there is no danger if the pilot keep some distance before the advancing front.

It appears from recent investigations at the Research Institute of the Rhön-Rossitten Gesellschaft that heights of 4,000 m. to 4,500 m. above the starting point may well be attained, in comparison with the existing record of 2150, and that the cross-country record of 150 km. may be increased in like proportion.

Fig. 28 shows a flight with towed glider at the Wasserkuppe and Fig. 29 shows a flight with towed glider at Darmstadt.

Systematic experiments have been carried out by the Society with gliders towed by power aeroplanes and released at a sufficient height to reach regions of up-currents and to continue independent cloud flying.

The performances recorded above show that flying without engine power, by using the energy of rising currents in the atmosphere, is an established technique. We cannot, indeed, expect it to meet the requirements of air transport, but its value as a sport cannot be questioned, and as such it is on a high level in its demands for physical fitness, skill, quick decision and courage, and in addition for a serious study of the scientific and technical problems involved.

Especially, soaring flight has had a beneficial effect on the design of light aeroplanes which now give performances with low engine power which were possible formerly only with powerful engines. The soaring glider with an auxiliary engine is unsatisfactory both as a glider and as a power aeroplane, and this line of development has been given up in Germany except for special research work.

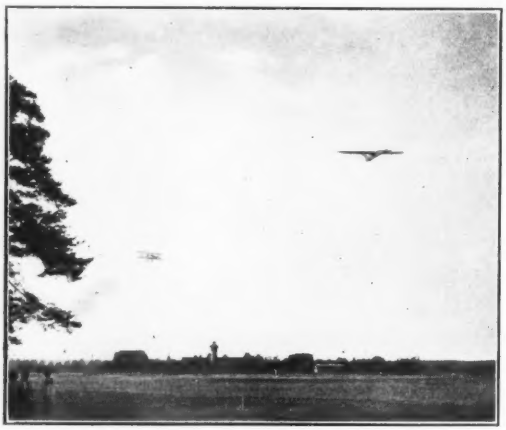

FIG. 29.
Towed flight at Darmstadt.

THE PROSPECTS OF SOARING FLYING

The Research Institute of the Society has recently established a new and important system of aerodynamical tests of new aircraft types. In the first place free flights by large models of three to four metres span are carried out at small cost. When all that can be learned from the models has been recorded, gliders of similar aerodynamical form are built and tested by a pilot in different flying altitudes. Finally, an engine is fitted and ordinary flying tests are carried out. In this way the successive steps in the development of a new type are carried, with minimum of cost and danger, to a point where the design of the full-sized aeroplane offers no serious uncertainties.

The tailless " Storch " (Stork) was developed on these lines.

Fig. 30 shows the " Stork " in model size.
Fig. 31 ,, ,, in glider size.
Fig. 32 ,, ,, as a light aeroplane.

Fitted with an 8 h.p. engine it attained a speed of 125 km./hr., and attracted much attention at the Tempelhof Flying Ground by its speed, manœuvring and great stability, and gave impressive evidence in favour of this type of design. The question remains whether gliding is a sound basis

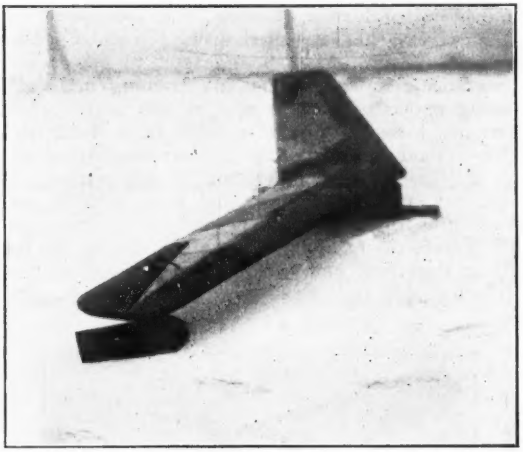

FIG. 30.
Tailless aeroplane "Storch" as a model.

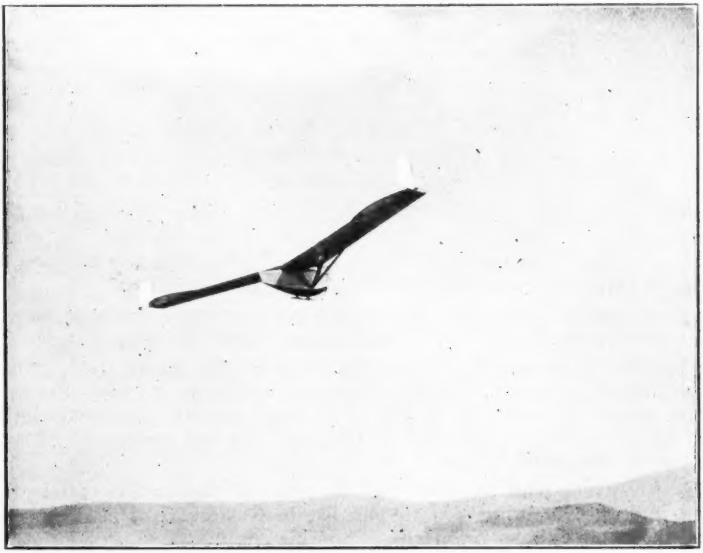

FIG. 31.
The tailless aeroplane "Storch" as a sailing aircraft.

for piloting a power aeroplane. Opinion is divided, but it may be taken that gliding is a sound basis for further training, and soon tests the balance, touch and eye. But a pupil who has mastered every branch of gliding still requires comprehensive further training when he goes on to power aeroplane piloting. Of far more importance than the preliminary training in hand and eye, is the extension of piloting experience to the special lore of the currents of the air, gathered in far richer measure during a flight of a hundred kilometres from hill to hill and from cloud to cloud, than in year-long flying on power aircraft. Such experiences will give a new generation of flying men a body of weather wisdom by which they may safely meet and even turn to useful purpose the atmospheric disturbances so frequently met with in air transport to-day. Pilots of this school will imitate the exploits of Kronfeld, and so far from fearing wind and weather will master them and ride the storm front in their flights across the land. The true meaning of " air sense " lies in this conquest of the variable

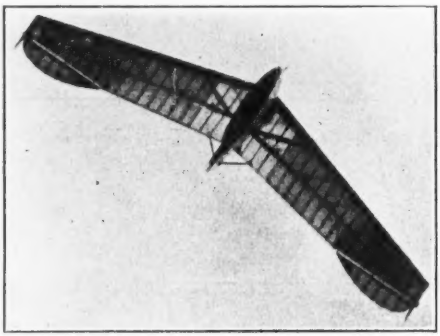

FIG. 32.

Tailless aeroplane " Storch " with 8 h.p. D.K.W. engine.

atmosphere by the soaring pilot. Just as the master of a great liner must serve an apprenticeship in sail craft to learn the secret of sea and wind, so should the air transport pilot practise soaring flights to gain wider knowledge of air currents, to avoid their dangers and adapt them to his service.

In confirmation of this view, pilots with soaring experience have shown their special worth in the difficult Lufthansa service across the Alps.

It has not been possible within the limits of this paper to describe more fully the growth of soaring flight, its present activities, its new problems and its future scope. I would call in aid all civilised nations, and particularly your own, in advancing its achievements to a higher level and opening to its activities all regions of the earth, temperate and tropical.

May I conclude with the hope that the unusual combination of scientific and sporting interest will bring you to join us, in friendly rivalry, in opening the regions of the air to man by means of soaring flight.

THE FLYING SCHOOL AT THE WASSERKUPPE

BY

FRITZ STAMER

The site of the Flying School was selected on a gentle eastward slope about midway between the southern slope of the "Wasserkuppe" and the western slope of the "Weltensegler," a ridge running at right angles to the former, the slopes of which are most used for training glides. The hangar, 60m. by 12m., was built of timber, with a cantilever roof requiring few supports and with drop doors at each end. The pupils are boarded at the school for convenience and for better supervision and direction of their spare time activities. It was also necessary to provide workshops and offices, and quarters for the mechanics and instructors and for the head of the school. A single building, also 60m. by 12m., adjacent to the hangar contains living quarters below, and a workshop above; a long central passage leads to a hall, on the south side, off which are the quarters of the Director of Research and of the Head of the School, and the kitchen premises; on the north side a woodworking shop equipped with a combined plane and shaping machine, a combined circular saw milling and slotting machine, and a hand saw. On both sides of the passage are pupils' rooms, each equipped with four beds and four cupboards, etc., and accommodating four pupils. From 25 to 30 pupils can be boarded normally, but in recent years the average has been 40 to 45, the additional pupils being boarded in an annexe not far from the school buildings. Off the passage there are also reading and writing rooms and a wind channel room for experiment and instruction. On the south side are a few guest rooms, and instructors' and mechanics' quarters. Two covered passages connect quarters and hangar, and off these passages are sick bay, bath room, large washing room and laundry. Above the machinery is a materials store. The rest of the upper floor is occupied by the school workshop lit by a long skylight. It has benches for 12 to 15 mechanics, a lathe, drill, and welding plant for metal working, and wood working equipment. Electric lighting and power is installed. This building, like the hangar, is entirely built of timber, with double boards and sandstone filling, and with untarred papier maché roof. The central heating plant and coal store are in the cellar under part of the residential building. Water is pumped electrically from a small well, sunk in the hillside, into tanks in the school building. Common meals are taken in the dining hall, and instruction is given in the large lecture hall, both in Ursinus House. Lectures are given by the instructors and by Heads of Sections in the Research Department. The sheds in the neighbouring "flying camp" have also been taken over.

The beginners' course includes pupils holding only the A certificate for glider pilots. Pupils who have passed the B glider test or who hold full pilots' certificates are classed as advanced.

In a session of seven months from 200 to 250 pupils pass through the course, and fifteen gliders of five different types are in constant use:—

6 of Zögling type for beginners.
3 of Prüfling type for soaring practice.
2 of Hangwind for soaring in light winds.
2 of Canossa two-seaters for soaring.
2 of Professor type for high performance soaring flights.

—

15 total.

In the past year out of 269 pupils 139 passed the A test, 121 the B test, and 30 the C test. A course lasts for four weeks and concludes with the B test for pupils of moderate skill. Approved pupils then take the advanced course of four weeks' further training for the C test and for all types.

Methods of Training

Solo piloting only is taught in all German gliding schools. The instructor explains the conditions of steady flight and the effects of the controls, warns the pupil against common mistakes such as stalling and abrupt movements of the controls, and advises him to hold the control firmly centred and without movement during the first glide. The glider in use for this stage was designed from years of experience with a special view to avoidance of accidents, and cannot soar. It is towed over level ground for a short distance and is released when it reaches a limited height. In this way the pupil practises hops without much danger, even in a stalled landing, until he ceases to make false movements and can hold a steady glide. Solo instruction makes the pupil rely on himself from the beginning, while the presence of the instructor might give a false impression of competence. As the initial hops just clear the ground by a few centimetres the instructor, from the ground, can observe the pupil closely and estimate his progress accurately.

Instruction with dual control has been carried out with success, especially in clubs with a small number of pupils, for which it has certain advantages. But the greater complication of the dual control glider, and the greater calls on the instructor's time, prevent its adoption in schools. When a more suitable two-seater design has been evolved, dual control may become more important. At present a two-seater glider with low wing loading and a good gliding angle must have an undesirably large span and inertia.

In the Wasserkuppe district the best slopes for gliding practice face from S.E. by S. to N.W., while the prevailing winds are westerly. The slopes facing N. and E. are also good, so that the general lie of the ground is almost ideal.

For training and practice grounds there should be no ground obstructions within the gliding range, as beginners may lose direction or height at any moment, and the ground should have a fairly soft surface such as loose sand, moss, or slightly marshy soil, to mitigate bad landings.

For soaring flight by experts good starting and landing places within the range of flight are the only local ground requirements, and general suitability is judged by the prevalence of rising winds over a considerable area, such as a fairly long ridge, along which the pilot can soar to and fro without frequent turns, which are tiring and lose height. A horse-shoe ridge facing the wind and catching it as in a funnel sets up strong rising currents and offers good turning points at the ends.

To return to the early stages of training, there should be a choice of courses offering progressive difficulties. A slope with an angle equal to the gliding angle enables the pupil to glide for a hundred metres or more while a false manœuvre forces him to alight before his glider has time to assume a dangerous position. (In general, of course, flying near the ground is not specially safe).

As the pupil satisfies the instructor he is taken by slow stages further up the slope until he is able to pass the A test—a flight of at least 30 seconds in a given direction to a fixed landing point. From half-way up the slope he is able to practise turns, and proceeds by further stages until he gains the necessary confidence and skill to take from the higher slope the B test—a flight of at least 60 seconds, with right and left turns round given marks, to a fixed landing point. Twenty or thirty flights on the Zögling type are sufficient for the A and B tests. Towards the end of the four weeks' course the pupil is transferred to the " Prüfling " and " Hangwind."

Pilots in the advanced class have usually had preliminary training at a flying school, and begin at once on high performance machines, making long flat figures of eight turns in a region of rising wind, and developing thereby the soaring sense. After a further twenty or thirty flights—forty or fifty flights in all—the pupil takes the C test, which requires a flight of at least five minutes with continuous gain of height, altitudes of 200m. to 300m. above the starting point being not uncommon. The course is concluded by instruction on a high performance glider in which the C test is again passed.

There are, each year, one or two courses in long distance flights and in cloud flying for pilots holding the C certificate.

Starting.—The method of starting evolved by years of experience is as follows :—A rubber cable is passed through the ring hooked on to a hook attached to the glider. Two members of the starting party hold the ends of the cable and others hold the tail of the glider. The former walk forward till the slack is taken in. On a signal they run until the length is doubled, where, on a second signal, the tail is released, the glider slides forward, and gains speed till flying speed is reached. At the same time the tension in the cable decreases to nothing, the ring drops from the hook, and the glider is in free flight.

The flight is timed from the instant that the ring drops. The start resembles, closely, the start of an engined aeroplane against a wind.

Instruments.—No instruments are fitted to gliders for elementary instruction, and the pupils thereby develop an air sense. On long distance soaring flights, a light compass is essential to determine the direction of path and wind. The air speed is determined by pitot tube, the scale being calibrated in metres/sec. High performance machines carry a sensitive barograph, giving the change in height to the nearest metre. Sealed barographs are carried in competition flights and in attempts on records. In research flights pressure gauges and inclinometers are fitted, and meteorographs are carried for recording air conditions. The course includes lectures, and in unfavourable weather the pupils assist in the workshops in building and repairing gliders, which gives them experience in design and construction.

Objects.—The objects of the school are to give sporting facilities to keen young men at small cost, and thus to promote formation of private gliding and soaring clubs in Germany, to give training during vacation to academic aviation groups formed of students of aeronautics, and to give theoretical and practical experience to professional pilots of engined aeroplanes.

Discussion

The President: He thought it would be generally agreed that it would be more suitable to postpone the discussion on the paper until the dinner at St. Ermin's Hotel on the following Friday, but if there was anybody present who was specially anxious to say something that evening and who could not be present on Friday, perhaps they would put their questions briefly.

A Speaker: Is there any instrument for recording or indicating the upward velocities of the air from the ground or perhaps on the plane itself?

Dr. Lachman (speaking on behalf of the authors): No such instrument had yet been developed.

Mr. Manning: He asked for information as to the strength of the gliders and the factors of safety which experience had shown to be necessary. Further, could some information be given as to the aerodynamical properties of these machines, their gliding angle, or rate of descent at certain velocities?

Dr. Lachman: The factor of safety for the Prüding type was about six and for the Zögling type it was one. The figures were calculated out on a different

scheme to the English method, but if it were felt that the calculations were not trustworthy, then load tests were made and the load factor determined afterwards.

Mr. MANNING: Are there any special precautions taken in order to prevent these high aspect ratio wings twisting?

Dr. LACHMAN: The construction was such that the wings were prevented from twisting.

The PRESIDENT: There was no doubt that remarkable experience had been obtained in Germany in connection with gliding and soaring flight and the Royal Aeronautical Society was especially interested in the scientific and technical side of this movement. The Royal Aero Club also was very interested in the sporting aspect of gliding and soaring flight, whilst the Air League would support in every way the popularisation of something that, in his humble opinion, was going to be very big indeed in this country. They would all be interested to know that both Dr. Georgii and Herr Stamer were enthusiastic as to several sites they had seen within quite a short distance of London, so much so, that they described a certain place as a perfect Wasserkuppe, and in some respects even more perfect than the Wasserkuppe in that it offered advantages for gliding with the wind in different directions, which was not quite the case at the Wasserkuppe. He was quite certain that the gliding movement would grow and would receive a considerable amount of support. He for one fully believed it would be not only of great benefit to the general movement of aviation as a whole, but also to the youth of the country in that it would bring them into contact in the proper way with flying, with the design of craft and their construction and their operation in a manner that could not possibly be done to-day, due to the expenses incidental to power flying. In March Dr. Georgii was presiding over an important Conference at Darmstadt in connection with gliding at which some 300 or 350 people would be gathered together literally from all countries in the world. There were to be representatives from France, Holland, Belgium, America, Austria, Italy, and other countries, but at the present moment there was no definite indication that representatives were going from this country. He hoped that before Dr. Georgii and Herr Stamer returned to Germany it would be possible to give them such an indication.

Mr. D. R. PYE (Assistant Director of Scientific Research, Air Ministry): In seconding the vote of thanks and expressing his own pleasure at having the opportunity of welcoming Dr. Georgii and Herr Stamer in the name of the Director of Scientific Research, he explained that Mr. Wimperis—the Director of Scientific Research at the Air Ministry—extremely regretted that he was not able to be present that evening. Dr. Georgii had spoken of his experience of and interest in this matter during the past ten years and it was perhaps worth recalling at this moment that 17 or 18 years ago when he was walking along the South Downs he came across two young men—they were really only schoolboys—who were experimenting with gliders. Those two boys had since both had distinguished careers in aviation and their names were Roderick and Geoffrey Hill, both well known in the Royal Aeronautical Society. Therefore, gliding in this country went back a very long way. Dr. Georgii had spoken of the opportunities for research which were opened up by gliding. The main lines of that research, of course, would probably lie in meteorology, and after what had been heard that evening there could be little doubt about that. The Aeronautical Research Committee in this country had at the present time a sub-committee which was investigating what, for want of a better title, was called the structure of the air. That was being done for a very practical and vitally important purpose, namely, estimating the liability of airships to experience sudden extreme stresses due to the variation in local currents, and an investigation of that kind could not help being very much aided by the kind of research of which they had

been given a glimpse that evening. In aerodynamics also there were clearly great possibilities. The difficulty about aerodynamic research as carried on with power-driven machines was that it is very expensive and must necessarily be very largely a Government affair. Any research that was carried on by the Government became involved in all the paraphernalia of a programme of research and estimates of cost and in the employment of such officials as he himself apologised for being. From the early days, from the days of the alchemist, it always seemed that the best research had been done by individuals working for themselves along their own lines and following out their own inspirations and even to-day that remained true. A particular case was in the direction of wireless telephony and the enormous amount of valuable work that had been done by the amateur. It seemed now that the coming of the glider in this country would open up possibilities to the private individual of carrying out research which hitherto it had been impossible for him to do owing to its great expense. If he might just touch on one possible subject, it would be to say that some time ago they had a most valuable paper from the Professor of Aeronautics at Cambridge University, Prof. B. M. Jones, in which he estimated the behaviour of what he called the perfect streamline aeroplane, and it seemed to him that the final approach to that ideal streamline aeroplane would certainly be achieved and could be achieved by the motorless glider.

An Informal Dinner was held at St. Ermin's Hotel, London, on Friday, February 21st, when the discussion on the paper by Dr. Georgii and Herr Stamer was continued.

Colonel the Master of Sempill (President) was in the chair.

The PRESIDENT: He would ask those who desired to speak to put their questions briefly so that those who had kindly consented to act as interpreters would be able to get the questions down and obtain suitable answers. The discussion that evening would really be a joint discussion in which the Royal Meteorological Society was joining and they welcomed the President of that Society, Mr. K. Lempfert, whom he would ask to give his views on the work of Dr. Georgii and Herr Stamer. He also desired to welcome someone whose name was well known in meteorological work, namely, Sir Gilbert Walker, and also the Director of the Meteorological Office at the Air Ministry, Dr. S. G. Simpson.

Dr. LEMPFERT: From the meteorological point of view, there were two points which were specially interesting and they were perhaps the extraordinary use that gliding fliers had made of cumulus clouds, and the extraordinary use to which they had put ascending currents that were associated with line squalls, which, generally speaking, were regarded as dangerous areas to be avoided by anybody who took to the air. Dr. Georgii, in conversation with him, had stressed the great importance which should be attached to the development of gliding flight as it formed a sort of nucleus which brought together the aeronautical and the sporting interest, together with the meteorological and scientific aspects of the problem. They would all agree that aviation and meteorology had much to thank each other for and that the progress in one was closely bound up with progress in the other. Gliding flight which could be carried out at comparatively little expense, afforded an unique opportunity of bringing the two sides of the problem into close contact and he looked forward to a close liaison between the two aspects of the subject which could not fail to have most fruitful results for both sides.

Wing Commander G. F. PRETYMAN: How soon could an experienced pilot of the older days, who was still in good flying practice, learn to fly a glider and get up to 6,000 ft.?

Mr. ALAN GOODFELLOW: Speaking on behalf of the Lancashire Aero Club—and those pilots who were too heavy ever to hope to get up to 6,000 ft.—said

that they were on the point of placing an order for a glider, but were not certain whether to buy a machine of the Prüfling type or the Zögling type. They had been told that for the training of gliding pilots it was important that the pilot should be exposed as far as possible to the air and that the enclosed or cockpit type was not suitable for preliminary training. He would very much like to know whether the Prüfling type, in which the pilot was enclosed in a cockpit, was suitable for the training of those who had already flown power-driven machines and who were qualified pilots, or was it necessary to start with the Zögling type of machine in which the pilot was entirely exposed? The objection to the latter type was that he understood it was not easily transportable, and in order to move it from place to place it was necessary to take it very largely to pieces and re-erect it again before it could be flown from a hill. On the Prüfling type of machine that objection did not apply and therefore if pilots, who had already driven power machines, could learn to fly on the Prüfling type it seemed to him to be preferable.

Captain G. T. R. Hill: His gliding experience went back no fewer than 18 years, but as he had not done anything in the meantime he was obviously a little out of date. At the same time, it might be interesting to mention one or two things that he came up against in those days. At the present time there was an Air Ministry which limited them in all sorts of ways, but that was not the case at the time he went in for gliding. As a matter of fact, the chord of the glider he made was limited by the diagonal measurement of the frame of the window out of which the glider had to be brought and naturally the difficulties of construction were considerable! In spite of these difficulties, however, he actually managed to get the machine into the air and made a few short flights without breaking it. His chief claim to fame perhaps was that he believed he was the first person to glide at night. He had been trying all day, without success, to get the machine up and the day wore on until night fell. It was a November evening and it got dark early in the evening, but eventually he actually managed to get a little more speed than usual, and when he pulled the stick or rather the wheel, he suddenly realised he was in the air. He realised he was flying because he heard the wind whistling through the wires and he actually landed without breaking the machine or doing any damage.

He would like to know what method was adopted for measuring the rate of vertical descent of modern gliders. The rate of descent was very low according to the paper, and it seemed to him it would need very accurate methods of measurement to determine this with certainty. He had seen planes with a gliding angle of 1 in 28 and would like to know how these angles were measured and with what sort of accuracy.

Mr. P. Adjordan: The City and Guilds Engineering College was organising a Gliding Club, and he would like some information from the authors as to cost, methods of training, etc., and when the competitions were held in Germany.

Sir Gilbert T. Walker, F.R.S.: During twenty years' experience in India, he had been interested almost every day in watching vultures gliding about and could not help learning a certain amount from what he had seen. The most striking feature was the closeness with which vultures approached the stalling angle as they flew about, and he had been greatly impressed by the manner in which when they were flying close to the stalling angle they always had their feathers spread at the tip in a manner indicating very closely the Handley Page slot. He would like to know Dr. Georgii's views as to the likelihood of that being of value in gliding in future. Another small point was that in addition to the gliding by the use of ascending currents up a hill side—which were perhaps 5ft. to 10ft. per second and therefore adequate for going up 2,000ft. without the slightest difficulty every morning and remaining up all day long—was the fact

that on days when the sun was not shining and the sky was overcast, if there was no wind, the birds all remained in the trees. If the wind got up a little, the lightly built birds such as the kites came out. Now and again the heavier birds such as the lammergeier came out, but they went back after a few minutes because they could not stick it. They had to flap, but when the wind was strong enough not only did these heavy birds come out, but every bird in the neighbourhood. The sky, perhaps once a week, would be filled with birds who came out for the game of it. Some years ago he made some rough calculations from which he inferred that dynamical flying would be possible with the amount of turbulence which in England was associated with the wind of 30 miles an hour for birds whose angle of ascent was five degrees and whose normal flying velocity was 20 miles an hour. It seemed to him, therefore, that as far as he could guess roughly, something approaching dynamical gliding should be possible where the wind was fairly turbulent, when the velocity was not phenomenally high, and he would like to know whether this turbulence, which was a nuisance for power-driven machines, could be brought into use.

Mr. J. R. ASHWELL-COOKE: He would like to know whether any experiments had been carried out in Germany with regard to automatic launching. From what he had read he understood that the majority of the flying organisations in Germany were really secondary organisations and formed an integral part of some university or technical high school where it was probably very easy to get together the necessary crew to launch gliders at short notice. As far as one could see in these early days of the revival of gliding in this country, however, the method of distribution appeared to be somewhat on geographical lines and he foresaw difficulties in getting together the necessary crew at times, although on several occasions there would probably be available more than were necessary. That was a very important point and he was wondering whether some means of automatic launching could not be devised, thereby reducing the number of crew necessary.

Another point was whether gliders showed any tendency to go into a spin when stalled and whether quick recovery was possible. Moreover, was it possible to spin deliberately?

Finally, he would like to know the average landing speeds of the Zögling and Prüfling types of machine.

Squadron Leader R. A. de H. HAIG: Have any special instruments been developed to tell the glider pilot when he is gliding and when he is losing height? Experience had shown how difficult it was to tell whether one was flying straight when one was trying to keep a particular line of flight, and he would like to know whether any instrument had been developed for that purpose.

Mr. B. TIGHLMAN RICHARDS: As an old-timer he was glad to see this movement really forging ahead as it was at the present moment and he expressed the hope that it would continue to forge ahead at the same rate of progress for many years. It had to be realised that the evolution of the German glider was directly the outcome of Germany's persistence in the evolution and testing out of high lift ratio wings. Right from the start Germany had realised that a plane was only as good as its wing section, whereas over here we had been rather inclined to think that a wing section was only as good as the number of gadgets that could be put into the air.

His own experience in gliding went back to 1911 when he carried out gliding experiments at Kirkby-Lonsdale in Westmoreland, when gliding experiments on a scale never before attempted in this country were carried out. They did really soar and stay in the air for a few minutes, although perhaps with an intensity of fear. There was little doubt that the gliding enthusiast must be prepared to put in perhaps weeks of hard work for a few minutes enjoyment in the air, and

then to take the whole thing to pieces and start over again. He did not wish to appear pessimistic, however, because there was plenty of pleasure in building up again. The young members must not be discouraged if they had nothing but smashes to start with, nor should the clubs be disappointed if every new member who joined the club smashed the club glider. It was all part of the game; it really was a good game and he could recommend it as the best sport in the world. The great trouble in this country was lack of co-operation. He had on one occasion been speaking to a German who said that if you put twelve Germans into a sack and shook it up you would get a co-operative society, but if you put twelve Englishmen in a sack and shook it up you would get a dog fight. Certainly co-operation was not our strong point over here.

A point raised in the paper was that the German gliders had persisted in the use of the indiarubber rope, but it seemed to him that the variation in the tension on the two portions of the rope, unless a trained crew were used, might tend to interfere with satisfactory launching, and a little more information on that matter from the technical point of view would be interesting. As in the course of the experiments at Kirkby-Lonsdale it was found impossible to get sufficient people out of bed at two o'clock in the morning, which was the flying time, they endeavoured to devise a catapult arrangement. They fitted out a system of catapult launching by the use of a very light flexible wire rope through pulleys to a derrick. They acquired an old windlass from a lumber yard, costing 5s., and then scouted round to find a suitable weight. Somewhere in the neighbourhood they found an old gabled house with some big stone balls about it, and one night one of these balls fell off. It took them three nights to get it to the place where they were experimenting, because they had to roll it along at night and hide it by day in ditches, and it weighed 6 cwts. However, it made an excellent weight. They had a run of 28ft. The glider weighed 160lbs., and the factor of safety was .9.

Quite a number of machines were built and gliding went on for over a year. The measuring instruments were of the simplest possible description. The angle of glide was measured with a Starrett level and a piece of bicycle tubing, whilst the upward component of the wind was measured by using the smoke test used by plumbers.

Dr. G. C. Simpson: He did not propose to speak on the meteorological side as that aspect of the matter was so well represented by the President of the Royal Meteorological Society. He was, however, pleased to have the opportunity of seeing Dr. Georgii in England. It was five years ago that he first met him in Hamburg and since that time he had carried out a very fine trip across the South Atlantic to South America, investigating the upper currents of the atmosphere the whole way, and that work would be of tremendous use to both meteorology and aviation. Gliding seemed to him to have three aspects. There was the sports aspect, then there was the scientific aspect, and finally there was the industrial aspect. With regard to the scientific aspect, in this country they had always recognised Germany as taking a leading part in the world of science.

Mr. M. L. Bramson: The critical variable in flying with the glider, as with the ordinary aeroplane, was the angle of incidence. For any one glider there was a particular incidence corresponding to the minimum power which presumably was the same as that corresponding to the minimum rate of descent. Was it the practice to use any incidence indicator, or if not, would not such an instrument, if it could be made sufficiently light and simple, be very useful?

The authors had described methods of gliding flight which appeared to depend on rising currents and these in turn depended on variations in the country side from rising currents in or under cumulus clouds. On the other hand, very

little had been heard of what had been referred to by one speaker as dynamic gliding. Personally, he did not quite understand the mechanism of dynamic gliding, but so far as he had tried to understand it, it appeared to depend on the fact that the lift was proportional—not strictly perhaps—to the square of the speed variations and he would like to know whether there was any published information that described the laws governing such dynamic flight.

Lieut.-Commander C. N. COLSON: Is it considered in Germany that learning to fly as a glider is of any subsequent use to pilots wishing to pilot power-driven machines? Further, is experience in the design of gliders considered to be of any use in designing power-driven machines afterwards?

Mr. RUSSELL TAYLOR: Having had a little experience with sail planes, he had been instructed to do as little banking as possible, in other words, to do flat turns. In his small amount of experience with power planes, this was considered quite a dangerous performance as the machine was likely to get into a spin. Apparently the sail plane did not get into a spin under these conditions and some information on that aspect of the matter would be useful.

Mr. C. H. LOW-WYLDE: The film shown with the lecture illustrated pupils making their own machines. Was any form of inspection followed and what class of materials were used? Were they produced under rigorous inspection methods similar to those in force in this country? Were the design methods and aerodynamic qualities of gliders based substantially on those of the power-driven machine Finally, some German gliders had wings set at such an angle of incidence that it must be somewhat uncomfortable for the pilot. Was this the case?

Flying Officer LATIMER NEEDHAM: What precautions are taken in Germany to prevent pupils from stalling and how were the different categories of machines defined, namely, the sail plane, the glider and the intermediate machine?

Mr. W. E. GRAY: How is the fact that the air has a vertical velocity made sure of when determining on a descent, because it was very easy to get an error of 4 or 5 per cent. in the gliding angle?

Mr. D. R. PYE: Referring to the film shown with the lecture, all the landings were shown on a soft sandy country. In this country, however, it was more than probable that all the landings would have to be on turf lying in rather a thin layer on chalk, and he asked if Herr Stamer could give any information whether that fact would seriously affect the structural strength necessary.

Mr. J. P. BOUL: Could the authors state what were the conditions regarding No. 1 licenses for pilots and also as to the inspection of licenses on flights?

Mr. J. L. NAYLER: Have experiments been carried out with wings of variable camber to reduce landing speed and thus avoid damage?

Mr. F. HANDLEY PAGE: He would like to propose a cordial vote of thanks to the two authors for their lecture and also to the three translators—Dr. Lachman, Dr. Scherpenberg and Dr. Lempfert. Underlying the whole subject of gliding was the opportunity for re-capturing the spirit of the early days of aviation. Here was an opportunity for all who were eager to start in aviation to be able to do it without the enormous cost of having to purchase 500 h.p. aeroplanes. There were other considerations that might be worth while also, and in this connection a great debt of gratitude was owing to their German colleagues who had shown that in spite of all the difficulties with which they had had to contend, they had been willing to work perseveringly through to the end which they had been able to describe in such an interesting manner in the lecture. That was an extraordinary achievement because they had been faced with all sorts of discouragements.

Reply to Discussion

In reply to Wing Commander G. F. Pretyman, eight to ten flying days should be quite sufficient for an experienced pilot to learn to fly a glider. In order to get up to 6,000 feet the pilot in question should possess sufficient meteorological knowledge to enable him to get up to this height by making use of cloud currents and rising currents before line squalls.

In reply to Mr. Alan Goodfellow, in teaching soaring to pilots of power-driven planes, it is not absolutely necessary for the pupil to begin his instruction on a Zögling; a Prüfling could easily be used for this purpose. It would, however, be advisable to make the first attempts on flat ground, so that the pilot may first become familiar with the machine.

In reply to Captain G. T. R. Hill, the rate of descent is calculated by the barogram of a soaring plane. For instance, the rate of descent of the "Wien" from a glide of half an hour's duration, with approximately uniform, horizontal air movement, would be 0.71 m./sec. A gliding angle of 1 in 28 would certainly be somewhat too high a calculation (in calm conditions). Gliding angles of more than 1 in 20 have not been obtained with the types of soaring planes now in use.

In reply to Mr. P. Adjordan, the fees in the German schools for a four weeks' course amount to M.300—including lodging and insurance. The charge for board is M.3 per diem. The competitions in Germany take place in August.

In reply to Sir Gilbert T. Walker, no experiments have been made with slotted wings on gliding planes up to the present. However, it appears to be possible that they might be of great assistance in soaring flight. Mr. Handley Page has kindly given permission for a slotted wing to be used experimentally in a soaring plane. As regards the other questions regarding dynamical gliding, the turbulence which is such a nuisance for power-driven machines can certainly be made use of in soaring flight and is converted into flying energy. Satisfactory dynamical gliding has, however, not yet been found possible.

Replying to Mr. Ashwell Cooke, in Germany the start is generally made by means of rubber cords, but satisfactory results have also been obtained with starting devices. It is certainly possible to construct an automatic starting device which does not require the assistance of a special starting crew. As, however, the machine must be returned to the starting place after landing, the need for a ground crew still exists. Moreover, a mechanical starting device makes it more difficult to change the starting point frequently. No definite decision can be given as to whether gliders show any tendency to go into a spin. This depends on the wing cross-section used. It is possible to spin a glider deliberately by using the controls in the same way as with a power-driven plane. The average landing speed of the Zögling and Prüfling types is between 15 and 25 miles per hour. A glider is recovered from a spin by the same method as used on ordinary aeroplanes.

Replying to Squadron Leader R. A. de H. Haig, the pilot can tell when he is gliding and when he is losing height by means of a variometer. He can also tell this by watching the altimeter, which is so delicately constructed that it registers small variations in height.

In reply to Mr. M. L. Bramson, incidence indicators are not used. Mr. Klemperer has written an exhaustive work on dynamic flight which appeared in the minutes of the aerodynamical institute of the Technichische Hochschule, Aix-la-Chapelle. The handbooks on aerodynamics also deal with the principles of dynamic flight. It is dealt with in detail in Lanchester's work on aerodynamics.

Replying to Lieut.-Commander C. N. Colson, learning to fly a glider is a useful preliminary training for flying power-driven planes, as it teaches the

fundamental principles of flight. However, the chief value of gliding as a preliminary to ordinary flying is that the pupil becomes familiar with meteorological conditions and is able to gain experience in flying in and over clouds, and such experience should be very valuable for those who intend to pilot power-driven machines. By constructing gliders it is possible to acquire certain skill which can be usefully applied in the construction of power-driven planes.

Replying to Mr. Russell Taylor, gliders may be steeply banked. However, such banking is not good practice as it involves loss of height.

In reply to Mr. Low-Wylde, gliders built by clubs or private persons must undergo tests as to their airworthiness by so-called " construction examiners." Their decisions are not based on instructions issued by the Air Ministry, but on the data collected by Mr. Lippisch, chief of the Flugtechnische Abteilung des Forschungs-Institutes, based on the experience gained in the 10th Rhön Soaring Competition. The design methods and aerodynamical properties of gliders are based on those of the power-driven machine. However, the principles of construction of a glider naturally differ from those of a power-driven plane. I do not understand the last question as to angles of incidence which are uncomfortable for the pilot.

Replying to Flying Officer Latimer Needham, should a glider stall, the pilot attempts to regain normal flight by turning the nose of the machine down. The different categories of the machines are as follows:—Gliders, for instance " Zögling " (for beginners); " Schwanchwindsegler " and instructional gliders, for instance " Prüfling " (for advanced pupils for passing the " C " test); and high performance machines, " Professor," " Wien " and others (for experienced soaring pilots).

In reply to Mr. W. E. Gray, the velocity of an ascending wind on an ascent is deduced from the normal speed of the plane for the prevailing density. The difference between observed rate of ascent and normal rate of ascent gives the vertical velocity of the air. Errors up to 10 per cent. are of no importance, as it is of no practical importance if 5 m./s. or 5.5 m./s. is measured.

Replying to Mr. D. R. Pye, according to statements made by lecturers in England, the ground is very suitable for landings, so that the structural strength is not seriously affected.

Replying to Mr. J. P. Boul, the conditions regarding gliding and soaring licenses in Germany are as follows:—

> Gliding certificate " A " is no longer issued. For a straight flight with a smooth landing, of at least 30 seconds, the pupil receives the former " A " badge (one seagull).
>
> Gliding certificate " B ": Five flights of at least one minute with an S curve and smooth landing.
>
> Soaring certificate " C ": One flight of at least five minutes' duration over the starting point.
>
> Licenses must be produced to the police authorities before flight.

In reply to Mr. J. L. Nayler, aircraft of lower speed are, of course, rather sluggish as regards control, and therefore not particularly suitable for instruction in gliding. Reliable details regarding the various types of soaring planes are to be found in the " Zeitschrift für Flugtechnik und Motorluftschiffahrt " which can be seen in the library of the Royal Aeronautical Society. A sensitive statoscope has a great value for pilots. It would be particularly valuable if such an instrument could be made for registering.

ABSTRACTS AND NOTICES

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(*Prepared by R.T.P.*)

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Aircraft Design

Plywood Webs for Aeroplane Wing Beams. (G. W. Trayer, N.A.C.A. Rpt. No. 344, April, 1930.) (5.102/12751 U.S.A.)

Author's Summary. A method of arriving at the most efficient and economical web thickness, and hence the most suitable unit shear stress, is presented and working stresses in shear for various types of webs and species of plywood are given. The questions of diaphragm spacing and required glue area between the webs and the flange are also discussed.

Lepere-Weymann Metal Construction. (Luftwacht No. 1, Jan., 1930, p. 41.) (5.102/12752 Germany.)

A set of complete box sections threaded on to the spars build up the complete wing, sufficient rigidity being obtained without internal bracing by longitudinal internal corrugation of the metal strips making up the box section. Overlapping of the strips gives a smooth external surface. The incorporation of a radiator in the wing by placing the cooling tubes inside a wing groove increases the cooling during climb and produces little increase of drag.

The Influence of Size on the Structural Weight of Aircraft. (F. Duncanson, Aircraft Engineer (Supplement to Flight, Vol. XXII., No. 13) 28/3/30, p. 346A). (5.14/12753 Great Britain.)

Approximate relations are given between dimensions and weights of structural parts, and curves are worked out for the various relations involved. The conclusion is arrived at that there is no effective limit to the size of flying boats at present.

(*Abstractor's Note.*—It would be as well to await independent official trials of the real performance and load factor of the Dornier D.O.X. before quoting it in support of a conclusion).

Torsional Strength of Members of Typical Section used in Aircraft Design. (G. W. Trayer and H. W. March, N.A.C.A. Rept. No. 334, Mar., 1930.) (5.2/12754 U.S.A.)

Some elementary results are collected from the theory of elasticity, unusual sections and contour lines of equal strengths are plotted by Prandtl's soap film method, and the results are tabulated. The elementary elastic theory of non-homogeneous materials is considered mathematically.

A useful bibliography is given.

Forced Vibrations with Combined Viscous and Coulomb Damping. (J. P. Den Hartog, Phil. Mag., Vol. 9, No. 59, May, 1930, p. 801.) (5.2/12755 Great Britain.)

The differential equations of forced vibrations with viscous damping, with solid friction damping and with combined damping are written down and solved. Their validity is discussed and a large variety of numerical relations is given graphically for varying conditions. The method and results should be of interest to structural and engine designers.

Calculation of the Natural Frequency of a Cantilever Monoplane Wing. (S. R. Carpenter, Air Corps Information Circular, Vol. VII., No. 649, 1/3/30.) (5.214/12756 U.S.A.)

Formulæ are developed for estimating frequency in bending and in torsion of cantilever monoplane wings with stressed skin, which appear to give results within 10 to 20 per cent. of experimental determinations. These results may be considered satisfactory in view of the indeterminate nature of the stresses in the skin of the wing.

Calculation of Members in the Body and Tail of an Aeroplane. (E. Seydel, L.F.F., Vol. 5, No. 2, 11/10/29, pp. 73 to 106.) (5.24/12757 Germany.)

The type of frame first considered is built up of hexahedral cells, taken as statically determinate. A brief discussion is given of statically indeterminate cases. Seven numerical examples are worked out.

The application of the methods to aeroplane bodies of polygonal form is finally discussed in general terms.

Regulating Air Commerce. (K. M. Lane, Aviation, Vol. 28, No. 4, 25/1/30, p. 154.) (5.26/12758 U.S.A.)

A brief descriptive account is given of methods of specifying load factors, checking stress calculations, and issuing "Approved Type Certificates."

Calculation of 3-dimensional Aircraft Structures. (H. Ebner, L.F.F., Vol. 5, pt. 2, 11/10/29, pp. 1-72.) (5.26/12759 Germany.)

The forces and moments are classified and systematic symbols applied. The usual equations available in statics are formed and arranged according to frame types. Where the edge of a girder is a broken line difference equations carry the operation from bay to bay. Where there is continuous curvature the angular change takes the form of a continuous integral, for which tabulated coefficients are given. Schemes of equations are formed for statically determinate and indeterminate frames, the latter requiring the principle of least work for solution. In many cases to a sufficient approximation the indeterminate structure may be replaced by a statically determinate one. Numerical cases are worked out, and the article constitutes a short treatise on the subject. A bibliography of 22 references is given, all German with the exception of one, to Mayor.

On the Vortex System in the Wake of a Cylinder in a Fluid. (H. Levy and S. G. Hooker, Phil. Mag., Vol. 9, No. 57, March, 1930, pp. 489-502.) (5.3/12760 Great Britain.)

V. Karman's conditions for the stability of two parallel rows of equally spaced vortices are quoted along with Heisenberg's extensions. The calculated results were in fair agreement with experiment on a body towed along a channel with fluid initially at rest in a tank, for a particular value of Reynolds number.

Fage and Johannsen carried out experiments on a flat plate held in a current of air in a wind channel. Glauert made certain assumptions and derived expressions correcting some of V. Karman's results for channel effects, claiming good agreement with experiment in certain respects. The authors analyse the assumptions and find them irreconcilable with those of Heisenberg. Further, certain other results not quoted in comparison are in serious disagreement with experiment.

It is shown that the distribution of vorticity set up by the walls of the wind channel affects the results. The authors conclude that while V. Karman's results are substantially confirmed for a body towed in a fluid at rest in a tank, there is no valid physical basis for the comparison of the results, obtained on Glauert's assumption, with motion behind a body in a wind channel.

The Turbulence in Front of a Body Moving through a Viscous Fluid. (N. A. V. Piercy, Phil. Mag., Vol. 9, No. 60, May, 1930, p. 1038.) (5.3/12761 Great Britain.)

The turbulence in front of a moving body in a viscous fluid is investigated experimentally by means of a hot wire instrument and the existence of a considerable region of instability in front of a strut is inferred. This is associated with the oscillation of the dead-water point at the nose. An attempt is made to relate this instability to motion in a cylindrical sheet under inertia forces.

Joukowsky Transformations. (P. Dupont, Bull. Tech., No. 63, Nov., 1929, pp. 1-74.) (5.3/12762 France.)

Pages 1-54 give a resumé of the Kutta and Joukowsky transformations as developed by v. Mises and others.

Pages 55-70 express the tangential forces and the resulting moments in the form of integrals introduced by Blasius.

Pages 71-74 combine the two effects.

Joukowsky Transformations. (M. Girault, Bull. Tech., No. 63, Nov., 1929, pp. 77 to 121.) (5.3/12763 France.)

Pages 77-94 give geometrical examples of transformations.

Pages 95-101 discuss further the choice of profile and the distribution of pressure along the median section for a wing with finite aspect ratio.

Numerical tables and curves are given to facilitate computation.

Experimental Examination of the Theory of Lifting Surfaces. (M. Pris, Tech. Aer., Vol. 20, No. 8, 15/12/30, p. 234.) (5.3/12764 France.)

The expressions for the induced resistance, induced velocities behind the wing, influence of tunnel walls, the interaction of biplanes and multiplanes, turbulent resistance at surfaces, and for circulation, are evaluated and compared with experimental determinations. Comparisons are exhibited graphically and are on the whole satisfactory, but certain discrepancies are evident.

A note is added on the recuperation by fixed plates of the energy of eddies trailing from the wing tips. With certain settings an increase of lift and a decrease of drag are exhibited by the polar curves.

Wing Profile and Performance. (H. Müller, L.F.F., Vol. 5, No. 1, 31/7/29, pp. 1 to 28.) (5.31/12765 Germany.)

The characteristics of an ideal wing in a perfect fluid are summarised and compared graphically with the experimental results of various national laboratories, and in conjunction with formulæ of reduction of performance current in Germany are freely applied to indicate the lines of design for specified performance.

An Essential Characteristic of Conformal Representations of Wing Profiles. (A. Metral, C.R., Vol. 190, No. 2, 13/1/30, pp. 103-105.) (5.31/12766 France.)

Three conditions of validity are laid down for the application of conformal transformation to obtaining wing profiles.

The Effect of Rotation upon the Lift and Moment of a Joukowsky Aerofoil. (W. G. Bickley, Proc. Roy. Soc., A.127/804, 1/4/30, pp. 186-196. See previous abstracts Nos. 10/10932 and 6/8318.) (5.31/12767 Great Britain.)

In the present paper the problem is solved completely for the two-dimensional case of profiles obtained from a circle by a single Jowkowsky transformation.

After recapitulation of the expressions arising from the steam and circulation, the conditions arising from rotation are examined and the additional terms in the flow potential are established.

By combining the results the expressions for flight in a curved path are obtained. The analysis is compact and the final expressions are simple.

Abstractor's Note.—An extension of these elegant results to a wing of finite span at least to a sufficient approximation for practical use, should present no great difficulties.

Effect of Variation of Chord and Span of Ailerons on Rolling and Yawing Moments. (N.A.C.A. Reports No. 298, R. H. Heald and D. H. Strother, and 343, R. H. Heald, D. H. Strother and B. H. Monish.) (5.312/12768 U.S.A.)

The extensive numerical results of these two reports are tabulated and exhibited graphically. No general relations have been derived, but the advantages of upward movement of the proper aileron with no movement of the opposite aileron are pointed out. The mechanical application would present difficulties.

The Magnus Effect in Theory and Experiment. (F. Ahlborn, Z.F.M., Vol. 20, No. 24, 28/12/29, p. 642.) (5.32/12770 Germany.)

Prandtl's qualitative and to some extent quantitative theory of the Rotor left a number of points in need of further explanation.

The present paper shows experimentally observed flow in the axial plane, giving a clear notion of the centrifugal pump action which is possibly as important in setting up the circulation, as the shedding of the initial eddy, and has certainly an important effect on the final quasi-steady motion. In particular Prandtl's limitation that the dead points could at most become coincident, and could not leave the surface, is negatived.

Sketches of the formation of eddies have been made from cinematograph records. The phenomena as a whole are complicated.

The application to the rotor ship is discussed and a detailed reply from Haff is countered with vigour. The depressing failure of the rotor ship might have been avoided had the difference between abstract hydrodynamical theory and viscous fluid motion been kept in mind.

Experimental and Theoretical Investigation of Cavitation in Water. (Z.V.D.I., Vol. 74, No. 9, 1/3/30, p. 264.) (5.32/12771 Germany.)

The experiments were carried out with convergent and divergent channels, wing profiles and spheres. Experiments at Göttingen have shown that very small bubbles are formed in the water in the region of low pressure. These are due to the vaporisation of the water and are carried along by the stream. In certain cases, the bubbles may subsequently collapse giving rise to a considerable pressure impulse. It is probable that the pressure impulses are mainly responsible for the corrosive phenomena on propeller screws.

"Shatter" Oscillations. (E. H. Kennard, Phys. Rev., Vol. 35, No. 4, Feb., 1930, p. 428.) (5.32/12772 U.S.A.)

Forced oscillations were imposed on water in a pipe 31 metres long, connected at the far end to a tank, containing a considerable mass of water and over it air at a pressure of four atmospheres. On increasing the velocity of the stroke, a point was reached at which the fluid was unable to support the negative pressure at the trough of the pressure wave. The mass of the fluid became porous in the neighbourhood and oscillations, much below the speed of sound, were transmitted. The pressure waves consisted of isolated peaks. Tentative mathematical treatment is given. The phenomenon appears to be related to the formation of splashes. The physical discontinuity and the corresponding mathematical discontinuity offer difficulties in discussion of the phenomenon.

Thermal Convection in a Viscous Fluid. (R. W. Babcock, Phys. Rev., Vol. 35, No. 8, 15/4/30, pp. 1008-1013.) (5.32/12773 U.S.A.)

Following Oberbeck (Ann. d. Phys. 1879, p. 271) the differential equation of fluid motion and of heat diffusion are written down substantially in the form given later by Boussinesq (1903) and quoted by Rayleigh (Collected Papers, Vol. VI., p. 1916). The problems of convection between parallel vertical walls and vertical concentric circular cylinders, maintained at different constant temperatures, find simple solutions.

The case is considered of two parallel horizontal planes both maintained at temperatures varying harmonically along a fixed direction, and similar problems are constructed for horizontal circular cylinders.

The author makes no reference to the important problem, observed by Benard and solved by Rayleigh and others, of the criterion and mode of instability in layers of viscous fluid between horizontal plane boundaries kept at different constant temperatures, the lower boundary having the higher temperature. (Jeffreys, Proc. Roy. Soc., A.118, p. 195; Low, Proc. Roy. Soc. A.125, p. 180.)

Distribution of Pressure round a Cylinder in a Current of Water. (P. Dupin and M. Teissié-Solier, C.R., Vol. 190, No. 10, 10/3/30, p. 620.) (5.32/12774 France.)

Measurements are given of the distribution of pressures round a cylinder exposed to a current of fluid, and a brief note on turbulent flow is added.

The Existence of Two Families of Eddies behind Immersed Solids. (C.R., Vol. 189, No. 23, 2/12/29, pp. 972-974.) *Formation of Eddies behind Immersed Solids.* (C.R., Vol. 190, No. 6, 10/2/30, pp. 362-365.) J. Courregelongue. (5.32/12775 France.)

A description is given in the first article of an observed phenomenon. Two rows of small eddies with close spacing shed by the body roll up into larger eddies.

In the second article some extremely interesting sketches (p. 364) show as many as ten or more small eddies combining to form a larger one, which then exhibits the usual properties associated with detached eddies.

(*Abstractor's Note.*—The speed of propagation of capillary waves in water (23 cm. per second) appears to be critical. This was first pointed out by von Kármán, at Zurich (1926) International Congress, in answering criticisms of Benard, and fully explained the discrepancies between the experiments of the latter and the mathematical theory of the former. There appears to be a systematic attempt on the part of French writers to ascribe to Benard, whose work was purely experimental, the credit really due to von Kármán, who was the first to put the subject on a mathematical physical basis.)

Alternate Eddies. (P. Dupin and M. Teissié-Solier, C.R., Vol. 190, No. 15, 14/4/30, p. 920.) (5.32/12777 France.)

A number of experimental determinations of the periodicity of eddies formed behind a cylinder are plotted against the quantity $\frac{\text{diameter}}{\text{velocity} \times \text{periodicity}}$.

For values of Reynolds numbers above 1,000 this parameter appears to have the approximate value of two-tenths within fairly narrow limits.

The experiments are classified according as turbulence does or does not exist.

Effect of Reduction Gearing on Propeller Body Interference. (F. E. Weick, N.A.C.A. Report No. 338, March, 1930.) (5.33/12778 U.S.A.)

Full scale tests on two metal geared airscrews with diameters of 10 ft. 5 in. and 8 ft. 11in. were made with two different pitch settings and with large and small bodies. The tables and graphs show an increase of about 2 per cent. efficiency as compared with direct-drive airscrews. This is attributed to the smaller relative size of the body and to the forward setting of the hub.

Theory of Alighting Shocks in Seaplanes, 181st Report D.V.L. (W. Pabst, Z.F.M., Vol. 21, No. 9, 14/5/30, pp. 218-226.) (5.34/12779 Germany.)

The impulsive shock on a flat plate is calculated by the methods of hydrodynamics, along with the increase in the effective mass caused by the fluid moving with the plate, taking into account the elasticity of the water. An experimental determination of the latter is also made for forced oscillations, the effect of aspect ratio being taken into account.

Various systems of springs and masses are considered, in order to take into account the elasticity of the seaplane structure itself, and the appropriate differential equations are formed and solved, the pressure being harmonic. A numerical example is worked out.

Wedge-shaped floats are next considered, and in this case the elasticity of water has a negligible effect.

The calculated values for different speeds are exhibited graphically and compared with the load factor specifications of the D.V.L. For small seaplanes relative stresses up to 8 x gravity are found, a figure which exceeds the specified limit. In large seaplanes the calculated overload falls below the specified limit.

High Altitude Airscrews—German Patent No. 494763. Argus Motoren. (Flugsport, Vol. 22, No. 9, 30/5/30, Patents Supplement, p. 81.) (5.4/12780 Germany.)

A supercharged engine is fitted with one or more airscrews subsidiary to the main airscrew. At low altitudes they run light. At high altitudes they are brought into operation by clutches so that the full power can be absorbed without serious increase of engine speed.

The Joukowsky Circulation Theory of Airscrews. (W. Alexandrow, Fourth Congress for Air Transport, Rome, October 28th, 1927, Z.F.M., Vol. 24, No. 20, 28/12/29, p. 633.) (5.41/12781 Germany.)

Extensive priority is claimed on slender grounds for Russian Aeronautical writers. The usual expressions for torque, thrust and efficiency are formed, and various approximations of a more or less familiar nature are introduced to render the mathematical expressions tractable.

The calculated values are compared with experimental results from English and U.S.A. laboratories.

There appears to be no new result.

Test of an Adjustable Pitch Model Airscrew at Four Blade Settings. (E. P. Lesley, N.A.C.A. Tech. Note No. 333, Feb., 1930.) (5.43/12782 U.S.A.)

Author's Summary.—The model airscrew is designed for a uniform nominal pitch/diameter ratio of .7 and the blade settings used correspond to nominal pitch/diameter ratios of .5, .7, .9, and 1.1 at .6 radius. The tests show that airscrews of this type may be considerably changed in setting from the designed pitch angles and yet give excellent performance.

Full Scale Wind Tunnel Tests with a Series of Airscrews of Different Diameters on a Single Fuselage. (F. E. Weick, N.A.C.A. Report No. 339, March, 1930.) (5.45/12783 U.S.A.)

Torque, thrust and efficiency characteristics of four geometrically similar metal airscrews of diameters 9 ft., 9 ft. 5 in., 10 ft., and 10 ft. 5 in., have been tabulated and plotted. An increase of the order of 1 per cent. for a diameter increase of 10 per cent. is shown in the efficiency and power output curves.

Full Scale Wind Tunnel Tests on Metal Propellers of Different Blade Forms. (F. E. Weick, N.A.C.A. Report No. 340, Feb., 1930.) (5.49/12784 U.S.A.)

Author's Summary.—Five different aluminium alloy propellers having 4 different blade forms were tested on an open cockpit fuselage with a radial air-cooled engine having conventional cowling. The results show that (1) the differences in propulsive efficiency due to the differences in blade form were small; (2) the form with the thinnest airfoil sections had the highest efficiency; (3) it is advantageous as regards propulsive efficiency for a propeller operating in front of a body, such as a radial engine, to have its pitch reduced towards the hub.

Aerodynamic Theory and Test of Strut Forms. (R. H. Smith, N.A.C.A. Repts. Nos. 311 (Part I.) and 335 (Part II.) (5.56/12785 U.S.A.)

Author's Summary.

Part I.—In the 1st part the symmetrical inviscid flow about an empirical strut of high service merit is found by both the Rankine and the Joukowsky methods. The results can be made to agree as closely as wished. Theoretical stream surfaces as well as surfaces of constant speed and pressure in the fluid about the strut are found. The surface pressure computed from the two theories agrees well with the measured pressure on the fore part of the model but not so well on the after part. From the theoretical flow speed the surface friction is computed by an empirical formula. The drag integrated from the friction and measured pressure closely equals the whole measured drag. As the pressure drag and the whole drag are accurately determined, the friction formula also appears trustworthy for such fair shapes.

Part II.—In the 2nd part five theoretical struts are developed from distributed sources and sinks and constructed for pressure and resistance tests in a wind tunnel. The surface pressures for symmetrical inviscid flow are computed for each strut from theory and compared with those found by experiment. The

theoretical and experimental pressure are found to agree quantitatively near the bow, only qualitatively over the suction range, the experimental suctions being uniformly a little low, and not at all near the stern.

This study is a sequel to Furhmann's research on airship forms, the one being in two dimensions, the other in three. A comparison of results indicates that the agreement between theory and experiment is somewhat better for bodies of revolution than for cylinders when both are shaped for slight resistance. The consistent deficiency of the experimental sections which is found in the case of struts was not found in the case of airships, for which the experimental sections were sometimes above, sometimes below their theoretical values.

Motorless Flight. (Flugsport, Vol. XXII., No. 5, March, 1930, p. 74.) (5.8/12786 Germany.)

A description is given, with illustrations and constructional details, of the high-performance glider "Meiningen."

Motorless Flight. (Flugsport, Vol. XXII., No. 8, 16/4/30, p. 140.) (5.8/12787 Germany.)

Regulations for the 1930 Rhön Gliding Competition. Formal conditions of entry are given, along with the technical condition that the load divided by the aspect ratio shall not be less than 1.1.

A technical committee, a test committee and a meteorological committee control technical questions arising.

Navigation

Reduction of Noise in Aircraft. (H. E. Wimperis, Airc. Eng., Vol. 2, No. 14, April, 1930, p. 79.) (6.261/12788 Great Britain.)

Fechner's law of the relation of sensation to stimulus is stated, and the recently introduced quantitative unit of sound intensity is defined. It is pointed out that when two sources of equal intensity are present the suppression of one source affords negligible relief. The effects of reflection and absorption by walls are discussed. The advantages of walls which externally reflect sound and internally absorb it are brought out. These fundamentals determine the lines along which relief must be sought

Dissipation of the Energy Transmitted by a Sound Wave. (T. Vautier, C.R., No. 27, 30/12/29, pp. 1253-1255.) (6.261/12789 France.)

Expressions are obtained for the dissipation of energy of a sound wave in a pipe. Most of the loss of energy occurs on reflection at the ends, and depends markedly on the wave length. Pipe lengths up to 3,000 metres were used.

Insulation and Absorption of Sound. Method of Measurement. (E. Meyer, Z.V.D.I., Vol. 74, No. 9, 1/3/30, p. 273-279.) (6.265/12790 Germany.)

A special department (The Heinrich Herz Institute) for the study of all oscillation problems has been found at the Technical High School of Berlin. The department deals with mechanical, acoustical and electrical oscillation and the present article refers to the acoustical equipment. Till recently no suitable instruments were available, but microphones are now easily adapted for sound intensity measurements, just as loud speakers act as sources of sound. The microphone employed is of the capacity type and consists of a very thin duralumin diaphragm working in close proximity to a stationary electrode. By using two microphones the coefficient of sound transmission can be measured directly and its dependence on frequency investigated. For sound emission a specially modulated source possessing a certain width of frequency bands has been found useful.

Flight Test Instruments. (J. B. Peterson and G. W. Rounds, S.A.E., Vol. XXVI., No. 3, March, 1930, p. 313.) (6.3/12791 U.S.A.)

The errors are discussed, of altimeters, airspeed indicators, thermometers, revolution indicators. Diagrams are given showing errors found in calibration in typical instruments.

Gyro Compass for Gun-Fire Control. (S. G. Brown, Jnl. of Sc. Inst., Vol. 8, No. 2, Feb., 1930, pp. 40-49.) (6.344/12792 Great Britain.)

A description is given of the application of the author's balanced gyro directional instrument which maintains a fixed direction in space independently of the earth's rotation, for gun-fire control; gyro fly-wheel 4¼in. diameter; 11,000 r.p.m.; 12 volt d.c. motor; total weight of instrument 15lbs. Photographs of the instrument and a graphical record of damping after a roll of 15°, are reproduced. Considerable claims are made.

A New Method of Measuring Short Time Intervals. (W. Phillips, J. Sc. Inst., Vol. VII., No. 4, April, 1930, p. 126.) (6.44/12793 Great Britain.)

An indicating needle is carried by a moving coil, and undergoes a deflection in proportion to the current passing multiplied by the time. The current is measured in milli-amperes and the practical range is from 1/1000 sec. to 30 secs. The calibration depends upon the current passing through the coil.

Device for Measuring the Actual Rate of Flow of Fluid through Pipes. (Autom. Tech. Zeit., Vol. 33, No. 10, 10/4/30, pp. 251-252.) (6.51/12794 Germany.)

The flow meter is of the weir type and is of low resistance. The weir is in the form of a slot in a metal tube. The height of the liquid is measured in a capillary tube, after passing a chemical dye to facilitate reading. The weight is about 5lbs. and the delivery between 30 and 300 litres of fuel per hour. The accuracy is stated to be $\pm\frac{1}{4}$ of 1 per cent. under normal conditions.

Flying in Fog. (J. H. Doolittle, S.A.E., Vol. XXVI., No. 3, March, 1930, p. 318.) (6.6/12795 U.S.A.)

A descriptive account is given of the equipment of a naval training aeroplane for flying with instruments alone. These include an altimeter graded in 10 foot intervals, a directional gyroscope (not North seeking), and Sperry artificial horizon. Extensive radio direction finding equipment was installed including a vibrating-reed radio indicator, with wing tip antenna, in conjunction with a ground radio beacon, audible type, giving a localiser beam with an effective range of four miles.

Signalling with Ultra-Red Rays and their Use in Fogs. (Z.V.D.I., Vol. 73, No. 52, 28/12/29, pp. 1859-1860.) (6.61/12796 Germany.)

It has been found that the wave length of ultra red radiation must be less than 2μ in order to obtain the largest range through fog. The best results have been obtained with ultra red rays acting on a compound of thalium oxygen and sulphur known as thalofide. A thalofide cell is exposed periodically by means of a rotating mirror to two neighbouring strips of ground. If the ultra red radiating beacon is included in one of the strips, an electrical circuit is disturbed.

With a 6 cm. rotating mirror, ultra red radiations from a 4-volt pocket lamp were detected with certainty, after passing through 30 cm. of water, at a range of 8m. References are given to experiments on signalling by ultra red rays during the war and this application is considered promising.

Light Beacons for Night Flying. (W. M. Hampton, Airc. Eng., Vol. 2, No. 13, March, 1930, p. 64.) (6.62/12797 Great Britain.)

Visibility and range are discussed for varying weather conditions and for different types of lighting. An expression is given for the intensity required for a given range under varying conditions of absorption, and the results are exhibited graphically. Benford's results (U.S.A.) are reproduced, exhibiting, graphically, the fractions transmitted for different wave lengths and ranges.

The usual view is taken that Neon lights have no advantage in misty weather.

Oblique Absorption of Sound. (P. R. Heyl, V. L. Chrisler and W. F. Snyder, Bur. Stan. Jnl. Res., Vol. 4, No. 2, Feb., 1930, p. 289.) (6.76/12798 U.S.A.)

Author's Summary.—The absorption of sound at oblique angles of incidence has up to the present been purely a matter of theory, no experimental work having been published on the subject. Theoretical discussions have been given, which appear to be in error in an essential point, namely, the overlooking of the probable existence of rotational motion in the region of absorption.

It is found that the absorption varies with the angle of incidence, but not according to the law which has been deduced from purely theoretical considerations.

The conclusion has been reached that the tube method of measuring absorption is limited in its application to relative comparison of samples of similar nature, and that for absolute values of absorption the reverberation method is the only trustworthy one.

General Elastic Theory-Stress Optical Methods. (E. G. Coker, Engineering, Vol. 129, No. 3352, 11/4/30, p. 465.) (6.95/12799 Great Britain.)

A description with photographs is given of an extensometer indicating by means of a pivoted mirror and a beam of light. It is applied to measure the changes of thickness of specimens under tension, and thereby to determine the Poisson ratio in connection with stress optical measurements.

Critical notes are given on other types of extensometer also.

The Huggenberger Tensometer. (Engineering, Vol. 129, No. 3353, 18/4/30, p. 502.) (6.95/12800 Great Britain.)

A description is given with two photographs and a diagram. Magnification may be 1200 or 300, according to requirements. A specimen stress-strain diagram is given.

Electrical Recorder on the Principle of the Condenser Micrometer. (Z.V.D.I., Vol. 74, No. 8, 22/2/30, p. 243.) (6.95/12801 Germany.)

The condenser micrometer has been developed as a recording instrument by the firm of Siemens, and examples of the instrument are given when used as a torque meter and also for recording tool pressure in a lathe. A bibliography is appended.

The Guggenheim Safety Competition. (Aviation, Vol. 28, No. 6, 8/2/30, p. 236.) Articles by W. G. Brown, R. R. Osborn and E. P. Warner.) (7.0/12802 U.S.A.)

The first article covers the method of making specified test measurement. The second gives a descriptive account of the development of various details of the winning machine, with sketches of details. The third gives a descriptive account of the flying qualities of the winning machine.

A Three-Phase Automatic Pilot. (W. C. A. Beck, Airc. Eng., Vol. 2, No. 14, April, 1930, p. 80.) (7.4/12803 Great Britain.)

A photograph and diagrams are given of the Boykow gyroscopic control. Two coupled gyroscopes control the elevators and a single constrained gyroscope the ailerons, by means of electrical contacts and relays. A description is given of the coupling, electrical connections, servo-motor control, and the application to flying without control by the pilot.

Automatic Steering Tests. (N. Minorsky, J. Am. Soc. Nav. Eng., Vol. XLII., No. 2, May, 1930, p. 285.) (7.4/12804 U.S.A.)

A descriptive account is given of the experimental automatic steering control installed in the U.S.S. New Mexico. Photographs and diagrams of the electrical equipment are given and it is concluded that spotting aeroplanes are actually able to direct course and gunfire. Consequently the fleet itself may remain permanently protected from aircraft above as well as from ships on the surface by smoke screens.

Taking Off and Landing Runs. (R. S. Stafford, Aircraft Engineer (Supplement to Flight, Vol. 22, No. 13), 28/3/30, p. 346e). (7.51/12805 Great Britain.)

Formulae are developed from wheel and tailskid resistance data of an aeroplane for the length of rising and landing runs. The graphical curves given are convenient for quick estimation.

Aircraft Engines

Small Aero Engines. (N. N. Tilley, S.A.E. XXVI., No. 3, March, 1930, p. 346.) (8.12/12806 U.S.A.)

Photographs and some descriptive details are given of engines developing from 25 h.p. to 110 h.p. A summary of the discussion is given.

Siemens SH.20 Radial Engine. (Flugsport, Vol. 22, No. 9, 30/4/30, p. 156-158.) (8.14/12807 Germany.)

In addition to building the French Jupiter engine under licence the firm of Siemens have now turned out a large air-cooled radial engine of their own design. The cylinder construction is of the screwed head type with only two valves per cylinder. The crankshaft is built up. The maximum rating near the ground is 540 h.p. at 1800 r.p.m., just over 17 h.p. per litre of stroke volume.

Correcting Engine Tests for Humidity. (D. B. Brooks, Bur. St. J. Res., Vol. 3, No. 5, Nov. 1929, p. 795.) (8.18/12808 U.S.A.)

Author's Summary.—Data obtained on a 6-cylinder automobile engine indicate a loss of engine power with increasing humidity proportional to the volumetric loss of oxygen content of the atmosphere. It is shown that power and fuel consumption may be corrected by subtracting observed water vapour pressure from atmospheric pressure and using the result in place of barometric pressure in the usual correction formula. The humidity correction may be as large as that due to changes in barometric pressure.

Simple nomograms are presented for obtaining the humidity correction, both near sea level and at higher altitudes. An appendix gives methods of computation by these nomograms.

Vibrations Damped by Solid Friction. (S. Thomas, Phil. Mag., Vol. 9, No. 57, March, 1930, pp. 329-345.) (8.22/12809 Great Britain.)

The elementary differential equations of solid friction damping and of combined solid and fluid friction damping are formed and solved, examples are worked out and compared with experimental results, by which the conclusions are generally supported. The method will find applications in the damping of torsional vibrations.

Thermometry in Engine Research. (J. F. Alcock, Air. Eng., Vol. 2, No. 13, March, 1930, p. 57.) (8.25/12810 Great Britain.)

A synopsis is given of the methods of applying thermo-couples to the exploration of the temperature field in aero engines. The calibration of thermo-couples with difficulties of their application to moving parts, and the arrangement of the external circuit is discussed. A diagram of a typical installation is given.

Rate of Heat Transfer from Finned Metal Surfaces. (C. F. Taylor & A. Rehbock, N.A.C.A. Techn. Note No. 331.) (8.3/12811 U.S.A.)

Author's Summary. In general, it has been found that the effectiveness of a given fin does not decrease very rapidly until its distance from adjacent fins has been reduced to 1/9 or 1/10 of an inch. A formula for the heat transfer from a flat surface without fins has been developed, and an approximate formula for the finned specimens is also suggested. Three diagrams with photographs show the general arrangements. Results are embodied in figures 7 to 28.

Transference of Heat, Diffusion and Evaporation. (W. Nusselt, Z.A.M.M., Vol. 10, No. 2, April, 1930, pp. 105-121.) (8.3/12812 Germany.)

The differential equations of heat transference and of diffusion are of the same form. Radiation and absorption must be taken into account in considering heat transference.

When laminar flow prevails, sufficient approximation to exact expressions for velocity, etc., can be obtained. When turbulence appears Prandtl's empirical expression of the mean velocity in terms of the 7th or 8th power of the distance from the wall has proved to be useful and accurate. Reynolds number now appears in the coefficients.

A discussion is given of numerous "formulæ" of application by various writers, some of which are adversely criticised.

Finally a formidable portmanteau formula is introduced for the ratio of heat transference and evaporation coefficient in a cooling tower involving some twenty physical quantities.

(*Abstractor's Note.*—The value of such formulæ, apart from and outside the range of the experimental results on which they are based, is not always apparent. Clearly there is an endless variety of ways in which the "theory" may be fitted to the fact by judicious manipulation of the numerous coefficients.)

The Insulation of Heated and Cooled Surfaces. (J. S. F. Gard & R. S. Robinson, Jnl. Soc. Chem. Indust. Trans. & Comm., Vol. 49, No. 10, 7/3/30, p. 125). (8.3/12813 Great Britain.)

Till recently principally magnesium carbonate and pure cork board were used as non-conductors. Both high and low temperature work in modern times require new materials for insulators, among which aluminium foil with internal air pockets is favourably referred to. The technical requirements of insulators under various conditions and methods of test are described. A bibliography is attached.

The Effect of High Temperature Water Cooling on I.C. Engines. (Dr. Ing. Hecker, Z.V.D.I., Vol. 74, No. 15, 12/5/30, pp. 471-476.) (8.31/12814 Germany.)

Two B.M.W. engines were tested, a 55 h.p. 4-cylinder motor car engine and a 220 h.p. 6-cylinder aero engine. The cooling water mean temperature was kept constant during test, and varied from 20°C. to 120°C. in a serious of tests. With constant mixture the car engine power increased about 2 per cent. and the specific fuel consumption about 3 per cent., while the aero engine power was unaffected and the consumption decreased by about 3 per cent.

Cowling Tests—Performance of Aeroplane with Different Engine Cowlings. (O. W. Schey, E. Johnson, and M. N. Gough, N.A.C.A. Tech. Note No. 334, Feb., 1930.) (8.38/12815 U.S.A.)

A description of the various cowlings, clearly illustrated by numerous photographs; the performances are given in numerical tables and graphically.

The Lubrication of Engines. (O. Thornycroft and C. H. Barton, Airc. Eng., Vol. 2, No. 15, May, 1930, p. 109). (8.4/12816 Great Britain.)

Carbonisation is largely due to the incomplete evaporation and combustion of the lubricating oil in the engine cylinder. Probably the carbonaceous matter in crankcase sludge has been carried down from the combustion chamber. There are no satisfactory laboratory tests available at the moment for comparing the carbonising tendencies of various oils, and no tests for sludging. Any tests devised should be carried out in close conjunction with engine experiments.

Questions on Lubrication Discussed at D.V.M. Conference, 10/12/29. (Z.V.D.I., Vol. 74, No. 12, 22/3/30, pp. 371-372.) (8.4/12817 Germany.)

The questions discussed cover primarily the special lubricating requirements of instruments, the measurements of oiliness and the stability of lubricating oil. In the case of instruments it is important that the oil should not creep and should be chemically stable. Certain parts of the instrument such as ebonite or wood may act deleteriously on the oil. It appears that the presence of anti-catalysers does not afford complete protection against oxidation.

The Spreading of Lubricants on Solid Surfaces, Molecular Influence. (P. Woog, C.R., Vol. 189, No. 23, 2/12/29, pp. 977-979.) (8.41/12818 France.)

The spreading of certain lubricating oils on metal surfaces depended on the time of exposure to sunlight previous to the experiment. Similar results were obtained by exposure to a quartz lamp. Under certain conditions the difference in spreading was accompanied by changes in viscosity.

Measurement of Lubricating Quality of Oils. (V. Vieweg, Tech. Mech. und Therm, Supplement to Z.V.D.I.), Vol. 1, No. 3, March 1930, pp. 101-105.) (8.41/12819 Germany.)

If so-called boundary lubrication exists the molecules in the oil film must be definite y orientated to an extent which can be measured by the degree of rectification of an alternating current passing through the film.

Estimation of Lubricant Quality of Oils. (R. Voitlander, Z.V.D.I., Vol. 73, No. 48, 30/11/29, p. 1702.) (8.41/12820 Germany.)

A cylinder rotating about a vertical axis is pressed against a second cylinder rotating about a horizontal axis. Both cylinders are immersed completely in the lubricant to be tested and rotated at the same angular velocity. The torque transmitted through the horizontal cylinder is recorded as a measure of the lubricating quality of the oil. Experiments so far carried out show clearly differences in this

quality with constant viscosity. The friction depends markedly on the contact pressure between the cylinder and falls off with diminution of pressure. Of all the substances tested sugar solution showed the smallest coefficient of friction.

Oil Scraper Ring. (Autom. Tech. Zeit., Vol. 32, No. 35, 20/12/29, p. 808.) (8.42/12821 Germany.)

A new form of scraper ring is described which is considerably deeper than the normal type and which has a number of oil holes in the surface of the ring instead of a groove. It is claimed that this makes the passage of the oil into the interior of the ring easier. The absence of the groove and the deeper section make the spring tension practically identical with that of the normal piston ring.

Motor Fuels. (De Bataafsche Petroleum Maatschappij, French patent No. 667, 160). (Chem. Abstr., Vol. 24, No. 5, 10/3/30, p. 1203.) (8.5/12822 France.)

A motor fuel is prepared by dissolving an " anti-knocking " agent in a solvent itself insoluble in the fuel and dispersing the solution in the fuel, if necessary with a dispersing or emulsifying agent and a stabiliser. In an example $(COOK)_2$ is dissolved in water and the solution dispersed in benzine. In other examples solutions of potassium cromate, citrate, gallate are used.

Liquid Fuel. (I. G. Farbenind, A.-G. German Patent No. 485,945.) (Chem. Abstr., Vol. 24, No. 5, 10/3/30, p. 1203.) (8.51/12823 Germany.)

In a prior patent 448,620, liquid fuel is improved by addition of carbonyl compounds of the Fe group. The present patent describes the improvement of liquid fuels by addition of other organic compounds of the Fe group, such as a Fe derivative of acetylacetone, Fe oleate, Fe naphthanate, Fe acetoacetate and Fe benzoylacete.

Study of the Absorption Spectra of certain Mineral Oils, in the Visible Range. (T. D. Gheorghiu.) *Ultra-Violet Absorption Spectra of certain Carbohydrates.* (A. Andant.) Bull. Tech. No. 64, December, 1929.) (8.5/12824 France.)

Fuels and lubricating oils were subjected to the radiation from a carbon filament lamp of wave lengths from about 3,000 to 6,000 A.U. The absorption was measured electrically by photo-electric cells. Characteristic absorption spectra were obtained from various lubricating oils in dilute benzene solution and formed a useful means of identification. Characteristic ultra-violet spectra of the carbo hydrates were also obtained over a range of wave lengths from 2,000 to 3,000 A.U. with a hydrogen lamp as the source radiation. The degree of absorption was measured by a photo-electric photometer. The fuels included hexane, octane, nonane, decane, undicane, duodicane and cyclo-hexane.

Two Physical Properties of Fuels which determine Mixture Formation in Carburettor Engines. (Wawrziniok, Auton. Tech. Zeit., Vol. 33, No. 11, 20/4/30, pp. 292-294; and No. 12, 30/4/30, pp. 316-318). (8.51/12625/6 Germany.)

It is the function of the carburettor to atomise the fuel sufficiently finely to prevent separation. The stability of the fuel fog depends on the latent heat and the surface tension. Those fuels which have the lowest latent heat and the smallest surface tension provide the finest subdivision and the greatest stability.

The surface tension of a series of fuels has been measured by the author over a range of temperature. In the case of fuel mixtures it is shown that the resultant surface tension is not an additive property.

An apparatus is described in the second article for registering automatically the rate of evaporation of a fuel at various temperatures and various air pressures.

British Patent No. 308614, March 24th, 1928. (8.514/12827 Great Britain.)
Mercury cyanide is suggested as an anti-knock compound.

Knock-Rating of Fuels. (D. G. G. Brown, Autom. Ind., Vol. 62, No. 4, 25/1/30, p. 112.) (8.514/12828 U.S.A.)

The Department of Engineering Research, University of Michigan, is now prepared to issue certificates in Knock-Rating. A photograph is given of the N.A.C.A. 1-cylinder test engine. A diagram of the fuel system and a chart showing the knock characteristics as determined for certain standard fuels are given.

Variation of Ignition Temperature with Mixture Composition for Various Fuel Mixtures. (Grebel, C.R., Vol. 189, No. 21, 18/11/29, p. 850.) (8.514/12829 France.)

The nature of the parent fuel has a determining effect on the resultant type of combustion. Using petrol, ethyl aldehyde produces violent detonation. With gas oil on the other hand, the aldehyde only acts as an accelerator. Similarly acetic acid and ethyl alcohol have much less anti-detonation effect when added to gas oil than when added to petrol.

Comparison of Anti-Knock Ratings Determined in Different Laboratories. (C. H. Barton, C. H. Sprake & R. Stansfield, S.A.E. Jrnl., Vol. 26, No. 4, April, 1930, pp. 479-484.) (8.514/12830 U.S.A.)

The tests show that, within narrow limits, very concordant knock ratings for different fuels can be obtained with engines of widely different design and working conditions if temperature and speed are carefully controlled and settings are adjusted for maximum-knock mixture strength.

Detonation Characteristics of some of the Fuels Suggested as Standards of Anti-Knock Quality. (J. M. Campbell, G. Lovell & T. A. Boyd, S.A.E. Jrnl., Vol. 26, No. 4, April, 1930, pp. 485-486.) (8.514/12831 U.S.A.)

Data are given from work done on the universal testing-engine developed by the N.A.C.A. The fuel system is described and a chart shows the results of relative compression ratio based on pure normal heptane. Hydrocarbon mixtures are considered as a possible basis for a standard fuel. Undesirable characteristics seem to be eliminated when the blended materials give a straight-line distillation curve. The detonation characteristics of blends are discussed.

The Physical Chemistry of the Phenomenon of "Knock" and of "Anti-Detonants." (P. Lafitte, J. Chim. Phys. 26, 391-423 (1929) (Chem. Abstr., Vol. 24, No. 5, 10/3/30, p. 1207.)) (8.514/12832 France.)

Knocking is not due to pre-ignition and is not a true detonation. It is a type of vibrating burning. Anti-detonants have more effect on the propagation of combustion waves. These substances increase rate of oxidation of liquid hydrocarbons but decrease the rate for the vapour.

Knock Testing. (Nat. Pet. News, 15/1/30, p. 61 (Autom. Absts., VIII/2, 20/2/30, p. 43)) (8.514/12833 U.S.A.)

The knock rating of a fuel is obtained by comparing the compression ratio at which it knocks distinctly with that at which normal heptane knocks, and the result is given as the relative compression ratios of the standard fuel and the fuel tested. An injection pump supplies the fuel, which is mixed with a metered quantity of air before entering the engine, and this control of the mixture strength improves the accuracy of the knock determination.

Synthetic Benzol Process. (Chem. & Met. Eng., Vol. 37, No. 3, March, 1930, p. 189. (8.516/12834 Germany.)

A process for the production of synthetic benzol from blast furnace gas using the water gas reaction according to the Fischer method has been put into operation near Brom.

Synthetic Motor Fuel from Methane. (Z.V.D.I., Vol. 74, No. 9, 1/3/30, p. 279.) (8.516/12835 Germany.)

At the coal research institution of Mulheim the processes for obtaining motor fuels from methane are at present being investigated by Dr. F. Fischer.

Methane of 93 per cent. purity, obtained from coke oven gas by extensive cooling, is heated to 1,000°C. at ordinary pressure. An aromatic fuel was obtained.

A silent electric discharge is passed through coke oven gas at a low pressure. Hydrogen and acetylene are formed and on heating to 700°C. in the presence of catalysts again yield aromatic fuels. On subsequent heating to 250°C. in the presence of iron/nickel catalysts aliphatic fuels of the petroleum type are produced.

Mixture Distribution. (Alex. Taub, S.A.E. Jrnl., Vol. XXVI., No. 4, April, 1930, pp. 454-470.) (8.54/12836 U.S.A.)

The distribution in an engine is estimated by the curves of consumption per b.h.p. per hour and m.e.p. plotted against total consumption. Various types of induction pipes are described. The air stream should be balanced by equalising the compression pressure of the various cylinders before any other correction is attempted. Precipitation of the fuel is the most difficult problem and is best dealt with by the proper placing of hot spots.

The Use of Electrofilters for Cleaning Gases. (R. Heinrich, Z.V.D.I., No. 7, 15/2/30, pp. 193-199.) (8.542/12837 Germany.)

Industrial gases may contain dust varying in amounts between 1 and 100 grammes per cu. metre. By passing the air through a tube with a wire stretched along the axis at a potential difference of 70,000 volts between the wire and the earthed tube the dust in the air is almost completely deposited on the tube. The electrical energy required is from .05 to .5 kilowatt hours per thousand cu. ft. of gas treated. The electro filter is adaptable to the removal of tars and oils from high temperature gases in generator gas plants.

Injection Lags in a Common-Rail Fuel Injection System. (A. M. Rothrock, N.A.C.A. Tech. Notes, No. 332, Feb., 1930.) (8.59/12838 U.S.A.)

The fuel, contained in a high pressure reservoir, enters the pipe line to the injection valve by a mechanically operated timing valve. The injection valve is spring loaded and opens under the fuel pressure. A very short time after the timing valve needle has lifted a by-pass valve of considerable area is mechanically opened. The pressure in the fuel-pipe line to the injection valve drops rapidly and the injection valve shuts. The lag between the opening of the timing valve and the start of the spray increased linearly with tube length, but was not affected by bore. The lag increased slightly with valve opening pressure and decreased materially with increase in injection pressure. The initial pressure in the injection valve tube before the opening of the timing valve did not affect the lag, providing the injection pressure was considerably in excess of the valve opening pressure.

Compression Ignition Oil Engines. (R. Schulz, Airc. Eng., Vol. 2, No. 13, March, 1930, p. 63.) (8.59/12839 Germany.)

A brief specification is given of the Junkers SL1. Photographs are given of the crankcase of the partly assembled engine and of the complete engine mounted on an aeroplane. Drawings exhibit the cycle of operations of an opposed piston pair in a common cylinder, and two types of drive, in one with both pistons acting on a common shaft (Marine practice), in the other the pistons working on separate shafts, the latter connected by gearing (aeronautical practice).

The blower pressure appears to be 0.20 atmospheres; the compression ratio 1 : 14; the maximum pressure 38 atmospheres; the power 600 to 700 h.p. at 1500 to 1700 revs.; dry weight 1.2 to 1.4 kg./h.p.; length 1.7 metres, height 1.6 metres, width .51 metres.

Junkers Heavy Oil Aero Engine. (Engineering, Vol. 129, No. 3352, 11/4/30, p. 471.) (8.59/12840 Germany.)

Technical details are given with six photographs, diagrams, an indicator diagram and a graphical calibration of the scavenging effect. The consumption is given at 170 gm. per h.p. at 1500 r.p.m., the output as 700 h.p. at 1600 r.p.m., and the weight per h.p. 1.2 kg.

Combustion Chambers, Injection Pumps, and Spray Valves. (J. E. Wild, S.A.E., Vol. 26, No. 5, May, 1930, p. 587.) (8.591/12841 U.S.A.)

A descriptive review is given with diagrams of numerous types of combustion-chamber, injection nozzles and injection pumps in use in various solid injection oil engines.

The High-Speed Oil Engine. (Am. Soc. Nav. E., 41, 394-430 (Eng. Absts. No. 42, Jan., 1930, p. 130.)) (8.591/12842 U.S.A.)

In a paper presented to the American Society of Automotive Engineers, 25 high-speed solid injection engines in operation at the moment are described. The weight ranges from slightly under 5lbs./h.p. in the case of the Attendu engine to nearly 60lbs./h.p. in the case of Diesel locomotives. With even moderate supercharge, 3 to 4lbs. per sq. in. thorough scavenging is ensured with improved performance for weight.

On the Possibility of Applying the Cathode-Ray Oscillograph to the Indicator for High-Speed Engines. (Juichi Obata and Yukio Munetomo, Report of the Aeron. Res. Inst., Tokyo, No. 57, Feb., 1930, Vol. 5, 4.) (8.032/12843 Japan.)

Author's Abstract. Investigations were made to employ the cathode-ray oscillograph in place of the usual Duddell oscillograph in the electrical indicator described in a previous paper. It is found that the Johnson type cathode-ray oscillograph may be employed with some modifications of the electrical arrangement; a special device being introduced to indicate the piston position. Photographic record of the indicator diagram can be obtained for those engines for which the point-to-point indicator such as the R.A.E. indicator gives satisfactory results.

Diesel Locomotive with Compressed Air Power Transmission. (J. Greiger, Z.V.D.I., Vol. 74, No. 12, 22/3/30, p. 366.) (8.84/12844 Germany.)

The highest efficiency was obtained with an air pressure of three atmospheres. In order to obtain this efficiency it was necessary to inject water during the compression stroke and to heat the delivered air by means of the exhaust of the Diesel engine. The article deals with an experimental plant from which data for the final design were obtained.

A Compact Aero Engine. (H. W. Earl, S.A.E., Vol. 26, No. 3, March, 1930, p. 341.) (8.89/12845 U.S.A.)

A descriptive account is given of the advantage of an inclined cam drive (Swash plate drive). Some progress appears to have been made in the development of four-stroke-cycle engine of this type with 18 cylinders (9 at each end) parallel to the shaft, mounted in a circular case $17\frac{1}{2}$ in. in diameter, $5\frac{1}{2}$ in. overall length. What appear to be photographs of parts are reproduced. The profile of the cam intersected by a co-axial cylinder and developed on a plane consists of two complete harmonic waves, so that the four-stroke-cycle is completed during a single revolution of the shaft.

Materials, Etc.

Tensile Properties of Steels at High Temperatures. (J. R. Freeman, Jr., and G. W. Quick, Bur. St. Jrnl., Vol. 4, No. 4, April, 1930, p. 549.) (10.11/12846 U.S.A.)

A number of steels, particularly medium manganese rail steel, manganese molybdenum rail steel, chrome molybdenum tyre steel, one per cent. carbon steel and cast steel, were tested systematically after various treatments, and the ultimate tensile strength is plotted against temperatures up to 800°C. The diagrams show the mechanical properties. A number of micro-photographs exhibit structure.

Chrome Molybdenum Steel. (S. L. Gabel and H. C. Knerr, Aviation, Vol. 28, No. 13, p. 632.) (10.12/12847 U.S.A.)

It is stated that the chrome molybdenum steel denoted by number 1430X has become practically the standard material for aircraft construction in U.S.A. Apparently contact of this steel with another mark, No. 1025, has led to corrosion troubles in construction and even in storage.

The materials can be cold-drawn in tubes with the thinnest walls used in aircraft practice, and can be bent cold, machined readily and welded with comparatively small loss of strength.

A number of workshop photographs are given.

The article is continued in Nos. 15 and 17. In the last instalment (page 847) inspection and storing and accessories are discussed, and photographs are given of several applications to construction.

Protective Properties of Electro-Plating. (Aut. Ind., Vol. 62, No. 16, 19/4/30, p. 624, Abstract of Paper by L. Davis and L. Wright, Research Dept. of Metropolitan Vickers Electric Co. Ltd., to the British Institute of Metals.) (10.15/12848 Great Britain.)

The presence in the atmosphere of both $S.O_4''$ and Cl' ions is considered. A description is given of the apparatus for bringing a finely divided corroding mist into contact with specimen strips of 3 in. × 1 in. × 16 in. sheet. Deposits of cadmium, zinc, nickel and chromium were formed on strips of steel, brass, phosphor-bronze and copper exposed for $9\frac{1}{2}$ hours each day for 14 days, excluding week-ends. Progressive photo-stages were photographed, corrosion products were examined and appropriate conclusions were drawn. The somewhat intricate results are tabulated both for the degree of protection and for the nature of the corrosion products.

Four Essentials to Success in Chromium Plating. (Chem. & Met. Eng., Vol. 37, No. 3, March, 1930, p. 147.) (10.15/12849 U.S.A.)

The four essentials for successful plating are (i) temperature of solution, (ii) current density, (iii) nature and condition of surface, (iv) composition of solution.

Of these (i), (ii) and (iv) can be taken care of by proper design of the plant. The nature and condition of the surface to be plated is most important and determines the exact procedure to be adopted.

Protection against Corrosion. (J. E. Sullivan, Aviation, Vol. 28, No. 5, 1/2/30, p. 201.) (10.15/12850 U.S.A.)

Working rules are given from U.S.A. naval aeronautical practice in protection against various types of corrosion, particularly as regards inaccessible details.

Some technical details are given.

Anti-Corrosion Invention for Metal Aircraft, German Patent No. 493065. (A. Rohrbach, Flugsport, Vol. 22, No. 9, 30/4/30, Patents Supplement, p. 82.) (10.15/12851 Germany.)

The inventor proposes to cover the inside of the metal structure with a thin film of paraffin or similar liquid which prevents corrosion, the liquid being sealed in a series of compartments. External corrosion is dealt with by protective paint.

Theory of Metallic Corrosion—Part III. (G. D. Bengough, J. M. Stuart, A. R. Lee, Proc. Roy. Soc., A.127/804, 1/4/30, pp.42-70.) (10.15/12852 Great Britain.)

The reproducibility of corrosion experiments is of vital importance; sources of error may be due to variation in test pieces, or variable environment; in particular, vibration was found to cause more rapid corrosion in the experiment of Part II by setting up convection of oxygen.

The somewhat pessimistic conclusions of Part I are now amended and with adequate control of environment, annealed zinc specimens gave reproducible results within ± 1 per cent.

The numerous reservations made by the authors suggest that the numerical results are mainly on an empirical basis, but the elucidation of the detailed processes of corrosion in special cases is an indispensable preliminary to attempting a physical-chemical theory.

The Atmospheric Corrosion of Iron. (W. S. Patterson, J. Soc. Chem. Indust., Vol. 49, No. 17, 25/4/30, p. 203T.) (10.15/12853 Great Britain.)

A certain amount of atmospheric pollution is necessary to initiate rusting of either iron or steel. The deposition of water on the metal surface, either through a high relative humidity or through the hygroscopic character of solid impurities deposited from the atmosphere, will suffice to establish local electrolytic corrosion, provided the metal surface is in some respect non-homogeneous.

The Effect of Sea-Water on Painted Surfaces. (Dr. Barenfanger, Z.V.D.I., Vol. 74, No. 12, 22/3/30, pp. 373-375.) (10.15/12854 Germany.)

Whilst many paints are known which afford protection of iron against sea-water corrosion, these coverings are all attacked by certain organisms which destroy the covering and enable the sea water to start rust. Attempts made to destroy these organisms by adding certain poisons to the paint have so far failed and it appears that lasting protection can only be obtained if cheap stainless steel should become available for the covering of hulls.

Welding in Aeroplane Structures. (R. Granjon, L'Aérotechnique, No. 132, May, 1930, pp. 169-173.) (10.18/12855 France.)

The author, as director of a trade research association laboratory, working in conjunction with the S.T.Ae., gives a precis of the methods tried and adopted, and a descriptive account of rules of procedure, precautions, materials, methods, training of operators, and tests.

A chrome molybdenum steel has been adopted, following U.S.A. practice.

The greater rapidity of building welded aeroplane frames, one week for two operators as compared with several weeks for other types, favours mass production in war; operators can be trained in a fortnight. Educational courses have been instituted and it is hoped that French constructors will speedily make up the start gained by their competitors. The firms producing acetylene and oxygen no doubt hope to extend their markets in this legitimate way.

Lithium. (Autom. Tech. Zeit., Vol. 33, No. 11, 20/4/30, p. 280.) (10.21/12856 Germany.)

In the Edison Accumulator, the electrical capacity is increased by the presence of Lithium. Since 1913 the price of Lithium has fallen with increasing demand from 2/6 per gramme to 1/- per gramme, roughly from the price of gold to that of silver.

Small additions of Lithium give the aluminium alloy Skleron its exceptional hardness, and also give hardness to lead alloy bearing metals.

Rolls-Royce Aluminium Alloy "Hiduminium." (Autom. Ind., Vol. 62, No. 18, 3/5/30, p. 697.) (10.2101/12857 U.S.A.)

The composition, casting and machining and working properties of the new alloy are given. It is used for light alloy castings in Rolls-Royce cars and aero engines. Aluminium forms over 80 per cent. by weight, the other constituents being Cu, Ni, Mg, Fe, Ti, and Si.

Aluminium Specification. (S.A.E., Vol. 26, No. 3, March, 1930, p. 379.) (10.2101/12858 U.S.A.)

Proposed revisions of specifications for aluminium alloys and for protective coatings are discussed, and a number of examples of specifications are given.

The remarkable results of Alclad protection are referred to.

Physical Properties and Methods of Test for some Sheet Non-Ferrous Metals. (J. R. Townsend, W. A. Straw and C. H. Davis, Bell Tele. Lab., Reprint B.447, Jan., 1930.) (10.211/12859 U.S.A.)

Author's Abstract: This paper continues an investigation undertaken to secure a simple and reliable method of test for sheet non-ferrous metals and the development of commercial test limits.

The Rockwell hardness and tensile strength limits are given for four alloys of brass, and two alloys each of nickel silver and phosphor bronze.

The Corrosion of Aluminium Alloys in Sea-Water. (H. Bauermeister, Z. Metallk., Vol. 22, No. 4, April, 1930, p. 119.) (10.27/12860 Germany.)

Cast aluminium alloys underwent considerable corrosion when in contact or in close proximity with brass or bronze. The alloy known as KS Seewasser under these conditions behaves fairly well. The best protection so far is a covering of pure aluminium sheet first produced in the U.S.A. as "alclad." German varieties are Duraplat and Allautal.

Effect of Artificial Ageing on Mechanical Properties of Timber. (Lyon, Fron, and Fournier, C.R., Vol. 189, No. 23, 2/12/29, pp. 992-995.) (10.32/12861 France.)

On exposing timber to the action of air containing small quantities of ozone it acquires within a month the chemical and micro-structural properties of seasoned timber. With certain precautions it is found that artificially aged wood may be accepted for aeronautical construction.

Excess of ozonisation renders the fibre brittle, in resemblance to over-seasoned timber, *i.e.*, timber kept for twenty or thirty years in store.

Ageing of Rubber and its Retardation by the Surface Application of Anti-oxygens. (C. Moureu, C. Duffraisse, and P. Lotte, Ind. & Eng. Chem., Vol. 22, No. 5, 1/5/30, p. 549.) (10.52/12862 U.S.A.)

Three phenols were applied as anti-oxygens, in a 10 per cent. solution in ether and other solvents, to samples of rubber sheeting, which were subjected to heating for about 100 hours at 90°C. The degree of protection was measured by the tensile strength of treated and untreated samples before and after the heating process. In many cases the deterioration which normally accompanies the heating process can be almost completely prevented by suitable anti-oxygen application.

A bibliography and a list of patents are attached.

Durability Tests of Spar Varnishes. (C. L. Came, Bur. Stan. Jrnl. Res., Vol. 4, No. 2, Feb., 1930, p. 247.) (12863 U.S.A.)

Author's Summary: Fifty commercial spar varnishes, which had been tested for conformity to Federal specification No. 18b, were exposed to several accelerated weathering cycles and outdoors. Kauri reduction values were also determined. The varnish was applied both by whirling and brushing. Sand-blasted and non-sand-blasted panels were used.

The paper correlates the tests mentioned above and also gives the results of similar tests made on experiment varnishes, prepared in the laboratory from various oils and resins.

A short bibliography is given.

Electrolytic Deposits on Aluminium and its Alloys. (M. Ballay, C.R., Vol. 190, No. 5, 3/2/30, pp. 305-308.) (10.541/12864 France.)

The surface is either sand-blasted or strongly corroded by acid before the plating is attempted. Satisfactory results were obtained by using a hot solution of ferric chloride containing only a small quantity of hydrochloric acid, and the best of these with solutions containing between 6 and 22 grammes of iron per litre, the acid content varying from .1 to .7 moles. of hydrochloric acid per litre.

Effect of Turbulence in Wind Tunnel Measurements. (H. L. Dryden & A. M. Kuethe, N.A.C.A. Report, No. 342, April, 1930.) (11.16/12866 U.S.A.)

The results obtained by Blasius for laminar flow and by Karman for turbulent flow are quoted.

A definition of turbulence in terms of the mean size and number of eddies is given.

The relations between resistance and Reynolds numbers are plotted under varying conditions for spheres and streamline bodies, and the variety of possible results is brought out.

The general conclusion is that standardisation of wind tunnels so as to give dynamical similitude is not practically possible, and that the degree of turbulence must always be taken into account and should, if possible, be stated numerically.

Testing Aeroplane Wing Ribs. (The Engineer, Vol. 149, No. 3871, 23/3/30, p. 321.) (11.22/12867 Great Britain.)

A description is given of a static wing-testing apparatus, constructed by Sir W. G. Armstrong Whitworth Aircraft Ltd., for testing wing ribs with any prescribed distribution of load. A photograph shows the method of operation.

Airships

The Metal-Clad Airship. (R. H. Upson, S.A.E., Vol. 26, No. 5, May, 1930, p. 567.) (12.12/12868 U.S.A.)

A somewhat discursive statement of the performance of the U.S. Navy Z.M.C.—2 is given, with figures of weights, etc., along with an optimistic forecast of the possibility of a 100-ton metal-clad airship.

Airship Progress and Problems. (G. Fulton, J. Am. Soc. Nav. E. 41-30-63 (Eng. Absts. No. 40, July, 1929, p. 169.)) (12.12/12869 U.S.A.)

The new airships of the American Navy will have a displacement of 6½ million cubic feet. The hull of each ship will contain a hangar capable of housing five aeroplanes. In order to conserve helium an exhaust water recovery plant is fitted. Oil engines are contemplated, working in conjunction with fuel gas. From previous experience the loss of helium by diffusion through the gas bags will be about 1½ refills per year.

Is German Airship Construction Developing on Right Lines? (Prof. O. Krell, Luftwacht, No. 1, Jan., 1930, p. 33.) (12.13/12870 Germany.)

The author states that commercial airship navigation would require speeds of the order of 100 m.p.h.; while methods of handling the ship on the ground would have to be much improved to render flying to schedule possible. The new airship L.Z.128, under construction in Germany, will have insufficient power to give a notably better performance than its predecessor. It would be more profitable to spend the money on systematic research into airship drag and construction. Unless increased performance is obtained without making the size unwieldy, the airship could have no commercial future.

L.Z.128 Helium Filling. (Luftwacht, No. 1, January, 1930, p. 41.) (12.62/12871 Germany.)

It is intended to supply the new Zeppelin airship, L.Z.128, now under construction, with helium. In order to save expense the upper parts of the lifting bag will contain hydrogen which can be blown off if necessary. In this way it is intended to conserve the expensive helium as much as possible, while retaining a considerable protection against fire risk, since the hydrogen is situated at a considerable distance from the engine. The engines are to be run with power gas as in L.Z.127.

Wireless, Etc.

Radio Facilities in Aircraft. (E. L. Nelson & F. M. Ryan, S.A.E., Vol. 26, No. 3, March, 1930, p. 326.) (13.1/12872 U.S.A.)

Specifications are given of two weather and beacon receiving radio sets, with photographs and diagrams of connections. Careful shielding and bonding are recommended. A graphical record of the strength of the signals received from a weather report station is given.

Accurate Testing of Audio Amplifier in Production. (A. E. Thiessen, Proc. Inst. Rad. Eng., Vol. 18, No. 2, February, 1930, pp. 231-242.) (13.2/12873 U.S.A.)

The equipment is described, with photographs and diagrams of connections, and instructions are given for rapid comparison of amplification within the band of audio frequencies and of the undistorted power delivered, with calibrated standards.

An elementary mathematical theory of the measurements is given.

Standardisation in the Radio Vacuum-Tube Field. (W. C. White, Proc. Inst. Rad. Eng., Vol. 18, No. 3, March, 1930, pp. 373-390.) (13.2/12874 U.S.A.)

Author's Summary.—In vacuum-tube engineering the base dimensions, the filament voltage, plate voltage, and grid-bias voltage are the features that require standardisation to the greatest degree. The history and present status of standardisation of these features are given. Only tube types commonly used for broadcast reception and transmission are included.

Radio in Air Transport Operation. (H. Hoover, Jnr., S.A.E., Vol. 26, No. 3, March, 1930, p. 321.) (13.2/12875 U.S.A.)

About forty stations are being provided at 200-mile intervals from New York to San Francisco, and from Seattle to Key West, having a capacity of 2 kw. and a range of 125 to 250 miles, using International band 800 to 1200 metres. The system is used for broadcasting weather reports and for emitting directional signals. Additional wave lengths between 25 and 400 metres are assigned for aeronautics, and short wave apparatus is generally used.

The serious disadvantage of silent zones in short wave signalling is mentioned. Much attention is given to the fact of shielding being continuous in a grounded metallic shield.

Power Output Characteristics of the Pentode. (Stuart Ballantine & H. L. Cobb, Proc. Inst. Rad. Eng., Vol. 18, No. 3, March, 1930, p. 450.) (13.2/12876 U.S.A.)

From Author's Summary.—The type of pentode considered in this paper comprises a cathode, a control grid, a screen grid, a grid connected to the cathode to prevent the flow of secondary-electron current from the plate, and a plate. Experimental measurements on a specimen low-power pentode are given and an improved and simplified technique is described. The power sensitivity of the pentode is measured and compared to that of a triode under conditions of equal optimum undistorted output. The pentode was found to be the more sensitive and equivalent to the triode preceded by a stage of amplification giving a gain of 3.3.

The Output of Power Obtained from Vacuum Tubes of Different Types. (H. A. Pidgeon & J. O. McNally, Bell Tele. Lab., Reprint No. B.462, March, 1930.) (13.2/12877 U.S.A.)

Author's Abstract.—In the case of three-electrode tubes it is possible from theoretical considerations to compute, approximately, the electrical parameters a tube must have in order to give the maximum output power of a given quality obtainable under fixed operating conditions.

The electrical characteristics and output of fundamental, second and third harmonics of two of the more common telephone repeater tubes are given.

Since no sufficiently exact theoretical analysis of multi-grid tubes is yet available to permit the determination of the parameters of optimum tubes, a comparative experimental investigation of a number of such structures has been undertaken.

The power output of multi-grid tubes and of three element tubes is compared. The reasons for the comparatively large power output of certain types of multi-grid tubes are discussed.

Trans-Continental Air Transport Radio Set. (G. E. Everett, Aviation, Vol. 28, No. 15, 12/4/30, p. 753.) (13.2/12878 U.S.A.)

A descriptive account is given with photographs and technical details of the drastic simplification and lightening applied to radio sets in use in order to meet certain requirements. Weight was reduced from 165lbs. to 85lbs. The detachable connections were concentrated in a five point block, and it is stated that an inexpert rigger can remove one set and instal a new one in a few minutes.

Six cases of burning-out having occurred with the old sets all the circuits are now protected by fuses.

New Piezo Oscillations with Quartz Cylinders cut along the Optical Axis. (A. Hund & R. B. Wright, Bur. Stds. J. Res., Vol. 4, No. 3, March, 1930, p. 383.) (13.21/12879 U.S.A.)

Three possible modes of elastic vibrations exist, depending on the linear modulus of elasticity, the torsional modulus, and for transverse vibrations on both moduli.

In experimenting with a quartz cylinder cut along the optical axis various combinations of electrodes were used in conjunction with regenerative circuits brought nearly to self-oscillation. The resulting oscillations of the quartz crystal were studied by means of glow patterns, and the observed frequencies were compared with calculated values. From the general agreement the authors conclude that all oscillations are true piezo-electric effects and that torsional oscillations predominate.

In a footnote it is claimed that this is the first successful attempt to produce torsional vibrations along the optical axis.

Free Periods of Resonators. (E. J. Irons, Phil. Mag., Vol. 9, No. 57, March, 1930, pp. 346-360.) (13.21/12880 Great Britain.)

The electrical acoustic analogy is applied to the statement and solution of problems in resonators. The method will find applications to the measurement of sound intensity.

Quartz Control for Frequency Stabilisation. (Handel, Kruger & Plendl, D.V.L. Proc. Inst. Rad. Eng., Vol. 18, No. 2, February, 1930, pp. 307-320.) (13.21/12881 Germany.)

In sending from aircraft, quartz controlled transmitters were designed requiring only 2 watts for continuous communication up to 800 km. In receiving, noise vibration and magneto interference occurred. The most serious cause of trouble was mechanical vibration, to eliminate which it was necessary to stabilise the frequency of the receiver.

Several quartz control arrangements were investigated without success on account of change of quartz frequency with temperature and sensitivity to vibration. A successful arrangement was devised by which a strongly damped short wave (50m.) reception audion was controlled by coupling a separate quartz controlled Heterodyne with light loading and small temperature effect, while a long wave audion was coupled and tuned to the intermediate wave lengths thus produced (2,000m.). Several low frequency amplifying stages were connected in series with the tube. Perfect purity and constant frequency were maintained under intense mechanical and acoustic vibration.

The Radio-Beacon at Bobigny. (M. Cleriot, L'Aéronautique, No. 132, May, 1930, p. 174-181, No. 133, June, 1930, pp. 221-226.) (13.4/12882 U.S.A.) (See Abstracts Nos. 12883 and 12884).

The French authorities are following U.S.A. practice in introducing short wave signals of equal intensity from two frame antennæ crossed in a vertical plane giving bisector planes of equal intensity for the sounds received. A refinement is obtained by synchronising the beacons to give different alternate morse signals but overlapping so as to form a continuous uniform sound, *e.g.*, with the letters L and F overlapping so that the signal is continuous. To one side of the course the letter L emerges, to the other side the letter F. The effects of distance, azimuth angle, and angle between frame-settings on the intensity of reception is discussed in elementary mathematical form. The stability of the directional plane is affected by variable wave lengths in the two sending circuits, but may be mitigated by suitable adjustment of the receiver.

Visual Double-Modulation Type Radio Range, Application to Airways. (H. Diamond, Bur. Stan. Jrnl. Res. Vol. 4, No. 2, February, 1930, p. 265.) (See abstracts Nos. 12882 and 12884.) (13.4/12883 U.S.A.)

Author's Summary.—This paper deals with methods for aligning the courses of the visual radio range with fixed airways. It has previously been shown that the courses of the aural radio range may be shifted by the use of a vertical wire antenna in conjunction with the transmitting loop antennæ or by varying the relative power in the two antennæ. These methods are, in part, applicable to the visual system. In the aural system the goniometer primaries are excited alternately. This permits independent consideration of the field patterns due to the primaries. In the visual system this is not the case, as both goniometer primaries are excited all the time. Two cases present themselves, the condition when the currents in the primaries are in time phase and the condition when they are in quadrature time phase. The former condition results in two beacon courses which are 180° apart and cannot be shifted from this relationship. The latter condition yields four beacon courses. A mathematical analysis is made of this case, and the amounts of angular variation possible using several methods of attack are tabulated.

A method of obtaining small amounts of shift by an adjustment of the receiving equipment aboard the airplanes is also described; one of the reeds is shunted by a suitable resistance in order that the reeds will vibrate equally when on one side of the equisignal zone. This method permits of great flexibility in securing a desired course and is suitable only for employment with the visual system. Sample calculations are made for actual airway routes to demonstrate the several methods of attack.

Development of the Visual Type Airway Radio-Beacon System. (J. H. Dellinger, H. Diamond & F. W. Dunmore, Bur. Stan. J. Res. Vol. 4, No. 3, March, 1930, p. 425.) (See abstracts Nos. 12882 & 12883.) (13.4/12884 U.S.A.)

Author's Summary.—A directive transmitter is employed on the ground, making possible the use of simple apparatus on board the aeroplane. A simple receiving set suffices to make use of all the radio aids provided. Visual indication is provided on the aeroplane instrument board by means of a tuned-reed instrument. The pilot observes the vibration of two reeds. On the course the vibration amplitudes are equal. Off the course they are unequal, the reed vibrating with the greater amplitude being on the side to which the aeroplane has deviated.

Two types of beacon transmitters are described, the double modulation and the triple modulation. The former is capable of serving either two courses at 180° with each other or four courses at arbitrary angles. The latter serves 12

courses at any desired angles and is adapted for use at any airport located at the junction of a large number of airways.

Descriptions are given of the receiving set and receiving antenna system developed. Aeroplane engine ignition shielding is also discussed.

Special adaptations of the beacon system are being developed to facilitate landing in fog.

A Tuned-Reed Course Indicator. (F. W. Dunmore, Bur. St. Jrnl., Vol. 4, No. 4, April, 1930, p. 461.) (13.4/12885 U.S.A.)

A purely mechanical combination of three single reed indicators gives an instrument in which the combinations of maximum and minimum vibrations of the three reeds indicates 12 courses at 30° intervals. Details of the instruments and of the method of application are given.

Loth Navigation System. (R. J. de Marolles, Aire. Eng., Vol. 2, No. 15, May, 1930, p. 107.) (13.4/12886 Great Britain.)

A descriptive account is given of a method of holding course by the synchronisation of wireless beam messages from two rotating beacons. When the course is held reception is simultaneous. Departure right or left is marked by lag or lead of one signal on the other.

Graphs to Prof. Sommerfeld's Attenuation Formula for Radio Waves. (Bruno Rolf, Proc. Inst. Rad. Eng., Vol. 18, No. 3, March, 1930, p. 391.) (13.5/12887 U.S.A.)

Author's Summary.—A short summary is given of Prof. Sommerfeld's conclusions, with approximate expressions for the " numerical distance " and the angle determining various shapes of theoretical attenuation curves. At very great distances, the signals over flat ground are shown always to decrease as the inverse square of distance, while at short distances short waves die away approximately as the inverse square root of distance.

A New Transformation of A.C. Circuits with Application to Theory of Audition. (B. v. Jer. Pol., Proc. Inst. Rad. Eng., Vol. 18, No. 2, February, 1930, pp. 221-230.) (13.5/6.261/12888 U.S.A.)

On multiplying each term of a complex impedance by j j^2 and j^3 ($j^2 = -1$ in Steinmetz' notation) new circuits are obtained possibly involving negative resistances. Applying these to an impedance in series with a resistance and capacity in parallel, the new circuit exhibits a negative resistance in series with a resistance and inductance in parallel. The modified impedance is independent of the frequency, but the phase is not. A circuit obtained by this method was applied to throw out of phase the high and low pitch components of ordinary speech. An oscillogram showed phase differences, but the ear failed to note any deformation, in accordance with Ohm's acoustical law that only amplitude and not phase is sensible to the ear.

Wave Propagation over Continuously Loaded Fine Wires. (M. K. Zinn, Bell Tele. Lab., B.459, February, 1930.) (13.5/12889 U.S.A.)

Author's Summary.—This paper contains the results of a theoretical investigation of wave propagation along a pair of wires that are " loaded " by enclosing each wire in a continuous sheath of magnetic material. The results of greatest practical interest are certain approximate formulæ that are sufficiently simple to be adapted to engineering design studies, while having a high degree of precision for all practical dimensions and frequencies.

A Method of Measuring the Overall Performance of Radio Receivers. (H. A. Thomas, J.I.E.E., Vol. 68, No. 400, April, 1930, p. 475.) (13.5/12890 Great Britain.)

Author's Abstract.—This paper describes researches which have been carried out at the National Physical Laboratory for the Radio Research Board. An improved method of measuring the amplification of a radio receiver is described, together with the manner in which this method can be applied to practical cases, particularly at short wave-lengths. The apparatus covers a wave-length range of from 15 to 30,000 metres, and is capable of dealing with inputs of from 0.25 to 1,000 mV. over this range. After describing in detail the construction and operation of the apparatus the results of tests on four receivers of widely different types are given, and some general deductions are obtained from the properties of these receivers. In conclusion suggestions are made for a possible means of classifying receivers for different purposes.

Study of Noise in Vacuum Tubes and Attached Circuits. (F. B. Llewellyn, Bell Tele. Lab. Reprint B.461, March, 1930.) (13.5/12891 U.S.A.)

Author's Abstract.—The noises originating in vacuum tubes and the attached circuits are investigated theoretically and experimentally under three headings: (1) shot effect with space charge, (2) thermal agitation of electricity in conductors, (3) noise from ions and secondary electrons produced within the tube.

Multiple Signals in Short Wave Transmission. (T. L. Eckersley, Proc. Inst. Rad. Eng., Vol. 18, No. 1, January, 1930, pp. 106-122.) (13.7/12892 U.S.A.)

Transmissions from England to America are analysed on the basis of repeated reflection from the Heaviside layer and the production of multiple paths.

The minimum possible wave-length increases from 8.6 m. to 20 m. as ionic density decreases from sunset to sunrise; the attenuation decreases.

Transmission Characteristics of a Short Wave Telephone Circuit. (R. K. Potter, Proc. Inst. Rad. Eng., Vol. 18, No. 4, April, 1930, p. 581.) (13.7/12893 U.S.A.)

Author's Summary.—A method of observing and recording the audio-frequency transmission characteristics of a short wave radio-telephone channel is described. They appear to be the result of wave interference between signals arriving at the receiver over paths of different group or electrical length, possibly combined with the distortion produced by a progressive change in the angle of rotation of the polarisation plane with frequency over the signal band. The persistence of certain pattern shapes during the observation periods and the changes in these shapes from hour to hour suggest that they are the results of progressive rather than erratic disturbances in the transmission medium. Synthetic patterns used in the analysis of the characteristics are explained and illustrated. Types of audio-frequency distortion resulting from selective fading are discussed. The effect of frequency or phase modulation in producing distortion on such a circuit is considered.

Photoactivity of Selenium and Various other Substances. (G. P. Barnard, Television, Vol. 3, No. 25, March, 1930, p. 30.) (13.8/12894 Great Britain).

A summary of the present position is given, and diagrams are exhibited showing the relation between illumination and conductance. Eleven types of cell are considered. A list of 17 references is added.

Television in Germany. (Brig.-Gen. The Hon. A. V. F. V. Russell, Television, Vol. 3, No. 25, March, 1930, p. 10.) (13.8/12895 Great Britain.)

A brief statement is given of the position in Germany. There is an experimental station with a range of 100 km. on 418 metre wave-length; a German Television Society, with several well known technical authorities on the committee and a monthly journal (*Fernsehen*); a combine Company (*Fernseh A.G.*) including the Baird International Television Company, Loewe Radio Company, the Robert Bosch A. G., and the Zeiss-Ikon A.G. The laboratories and offices are housed in the Goerz Works near Berlin.

Television in Colours by a New Scanning Method. (H. E. Ives & A. L. Johnsrud, Bell Tele. ab. B.448, February, 1930.) (13.8/12896 U.S.A.)

Coloured television requires a coloured light source capable of following the variations of the signal current at high speed. A description is given of the apparatus available, of the general arrangements required for sending and receiving coloured television records, and of experiments carried out.

The apparatus required is much more complicated and costly than for monochromatic transmission.

Progress in Television in Germany. (Prof. F. Noack, Z.V.D.I., Vol. 73, No. 48, 30/11/29, pp. 1703-1705.) (13.8/12897 Germany.)

Television apparatus is manufactured in Germany at the moment by three firms, viz., Telefunken, Telehör and the German Television Society. Telefunken uses the process of Carollas, Telehör that of Minaly, and the German Television Society is working in conjunction with Baird. The three processes are described. Telefunken only attempted to transmit pictures of objects which can be placed in a dark room in close proximity to the sending apparatus. The other two methods attempt transmission of objects in daylight. All three processes are handicapped by the few impulses which can be transmitted per second without interfering with existing broadcasting stations. In this connection Telefunken are working at the moment on the utilisation of short waves, since they enable a higher frequency modulation to be employed.

Photography

Aerial Photography. (R. F. Whitehead, Aviation, Vol. 28, No. 21, 24/5/30, p. 1024.) (14.1/12898 U.S.A.)

A second descriptive article on the Alaska mapping expedition. 13,000 square miles were mapped in 1929. The mapping altitude selected is 10,900 feet. Some account is given of the photographic equipment and technique, and of the methods of reduction.

Survey Stereoscopes. (C. F. Smith, B. J. Photy., Vol. 77, No. 3651, 25/4/30, p. 240.) (14.1/12899 Great Britain.)

The advantages of stereoscopic observation of two prints of the same region, taken from different points during an aeroplane flight are made clear from the point of view of rapid estimation of contours of equal level.

All the usual precautions as to uniformity of height, direction, vertical orientation, etc., must be taken.

Photographic Self Timers. (K. N. Mathur & T. K. Lahiri, University of the Punjab, J. of Sc. Inst., Vol. 7, No. 4, April, 1930, p. 122.) (14.2/12900 India.)

Author's Abstract.—The performance of photographic self-timers has been investigated by means of a vibration galvanometer worked by an electric tuning-

fork. It has been found that the self-timers are quite reliable instruments in that exposures can be repeated with good accuracy, but no reliance whatsoever can be put on the readings indicated on the dial, which may be very much in error.

Miscellaneous

Searchlights and Sound Locators, Part I. (R. E. Gillmor & P. R. Bassett, Army Ordnance, Vol. 10, No. 59, March-April, 1930, p. 311.) (15.11/12901 U.S.A.)

Do. Part II., No. 60, May-June, p. 418.

Part I.—A description is given of the co-operation of sound ranging apparatus and A-A/c guns. The first article discusses principally the range of searchlights. A 150-ampere high-intensity arc will give 800 million c.p. on a mirror diameter of 60 inches, which is considered feasible for a mobile unit.

Part II.—Further details are given of the technical equipment, including anti-aircraft wireless. A distant electrical control is described.

Structure and Properties of Parachute Cloths. (H. J. McNicholas & A. F. Hedrick, N.A.C.A. Tech. Note No. 335, March, 1930.) (16.11/12902 U.S.A.)

Author's Summary.—The requisite properties of a parachute cloth are discussed and the methods for measuring these properties described. In addition to the structural analysis of the cloths, the properties measured are weight, breaking strength, tear resistance, elasticity, and air permeability. Based on a comparative study of all the cloths, specifications are drawn for the manufacture of silk parachute cloths, using either the plain or the mock leno weave.

Prevention of Fires on Motor Boats. (H. E. Nevell, S.A.E., Vol. 26, No. 5, May, 1930, p. 618.) (16.12/12903 U.S.A.)

The author presumably presents the views of United States underwriters, and his recommendations and the discussion are of corresponding interest.

The Effect of Lightning on an Aeroplane. (E. Burton, Aviation, Vol. 28, No. 4, 25/1/30, p. 149.) (16.22/12904 U.S.A.)

A descriptive account is given of tests carried out with a 3,000,000 volt discharge passing through a model monoplane of metal frame. The momentary current amounted to several hundred thousand amperes. The points under consideration are shock to passengers, damages to the ignition system, and the effect of hot ionised exhaust gases in forming the conducting path, fire hazards and fusing of metal joints. No conclusions are given. Reference is made to cases on record of Zeppelins having been struck by lightning, in only two of which has the hydrogen ignited. The bonded metal frame is considered to act as a Faraday Cage absorbing and dissipating the charge. Photographs of the terminals and of a spark passing through the model are given.

The Autogyro: Its Characteristics and Accomplishments. (Harold F. Pitcairn, J. Franklin Inst., Vol. 209, No. 5, May, 1930, p. 571.) (17.3/12905 U.S.A.)

A descriptive account is given with eight photographs, some of which are new, of the autogyro. The maximum speed is given as 105 m.p.h., with definite expectations of 120 m.p.h. when fitted with a 225 h.p. engine.

Flying from the "Lexington" and "Saratoga." (Lt. L. D. Webb, U.S.N., U.S. Air Services, Vol. 15, No. 5, May, 1930, p. 35.) (18.12/12906 U.S.A.)

A descriptive account is given of the routine on these ships during combined operations. There are three photographs showing the "Lexington" at full speed, with part of the deck covered with seaplanes with folded-back wings, and a biplane leaving the deck.

Breathing at High Altitudes. (R. Kaisar, L.F.F., Vol. 6, No. 2, 25/1/30.) (19.11/12907 Germany.)

Experiments were carried out on selected persons, under reduced total pressure and under reduced partial pressure of oxygen only, the total pressure remaining atmospheric. The quantity of air per breath and the number of breaths per second were noted, the exhaust air was analysed, blood tests were taken, the general physical condition was recorded and the experiments were co-related with flight tests. Reduction of the partial pressure of oxygen has in general a less deleterious action in its immediate effects than reduction of the total pressure. The after-effects of reduced partial oxygen pressure at ground level were much more severe than those observed in the altitude chamber, but in most cases they could be almost entirely eliminated by a short period under high pressure. Additions of small quantities of carbon dioxide materially reduced the oxygen requirement at altitude.

Various types of apparatus for the supply of oxygen were tested.

Studies in the Physiology of Flying. (H. Strughold, Z.F.M., Vol. 21, Part 9, 14/5/30, pp. 226-228.) (19.2/12908 Germany.)

Investigations were made on the accuracy of movements of the limbs with reduced pressure and diminution of oxygen.

There was little effect with partial oxygen pressure 70 normal; thereafter control and accuracy of movement fell off rapidly.

The quantitative methods are described and the results are exhibited graphically.

Physical Standards for Pilots. (L. H. Bauer, M.D., & H. J. Cooper, M.D., Aviation, Vol. 28, No. 11, 15/3/30, p. 520.) (19.2/12909 U.S.A.)

A brief descriptive account of the methods applied in assessing physical fitness for pilots. Examples are quoted of accidents arising from pilots having flown in defiance of medical advice. A mean between laxity and undue severity is essayed.

The Air Port Problem in New York City. (J. C. Holme, Aviation, Vol. 28, No. 4, 25/1/30/, p. 157.) (20.0/12910 U.S.A.)

An account is given of some of the thirty air ports constructed in and near New York. Two air photographs are given, with the location of landing grounds marked. The problems of co-ordination, equipment and control are discussed.

The "Kangaroo" Device for Picking Up and Dropping Loads in Flight. (Ill. Flug., Vol. 2, No. 12, December, 1929, pp. 241-242.) (20.41/12911 Germany.)

Weights of the order of 10 lbs. were successfully dropped and picked up. Places without an aerodrome can thus be linked up postally at little expense.

(Abstractor's Note.—The above apparatus is sometimes known as the the Angumunde apparatus.)

High Voltage Research. (Electrician, Vol. 104, No. 2701, March, 1930, p. 295.) (21.0/12912 Great Britain.)

A description is given of the Metropolitan-Vickers Laboratory at Trafford Park, with remarks by Sir Ernest Rutherford on the direction of research on the subject of the Dessauer circuit. Two 500 kVA 50-cycle transformers give 500,000 volts. to earth, 1,000,000 across terminals.

Photographs of laboratory apparatus and of flash-over sparks at high voltages are given.

Far East Airways. (Lt. T. D. White, U.S. Air Services Mag., Vol. 15, No. 3, March, 1930, p. 32.) (O.R./12913 U.S.A.)

Brief notes compiled at the American Legation at Peking are given of developments by eight nationalities in the Far East.

Aeronautics in Latin America. (B. V. York, U.S. Air Services Mag., Vol. 15, No. 3, March, 1930, p. 30.) (O.R./12914 U.S.A.)

A summary of information compiled by the Department of Commerce is given, with some statistics and a chart of air services in operation.

Aviation Credit Corporation. (L. Mitchell, Aviation, Vol. 28, No. 4, 25/1/30, p. 162.) (O.R./12915 U.S.A.)

This article describes the Company's policies and methods of financing construction.

N.A.C.A. Budget. (Aviation, Vol. 28, No. 27, 15/2/30, p. 349.) (O.R./12916 U.S.A.)

A summary is given of the estimates for 1931, showing an increase of $29,000, bringing the total to $1,320,000.

A summary of new buildings and equipment is given, and includes a new seaplane channel (tank) 2,000 feet long, for research on hulls and floats. The full size wind tunnel is approaching completion.

A list of members of the Committees is included.

"WAPITI" STEEL WINGS

BY

BRIAN MARTIN

Lecture delivered before Yeovil Branch, December, 1929.*

With the present-day normal type of wing the spars are the principal members, and I propose to start by tracing very briefly the evolution of the spars which are used in the Wapiti wings to-day.

The personnel of the Steel Wing Company have been designing and making spars ever since 1912. I shall start from the time when we first began to use what might be described as the box type of spar, which was composed of four strip steel sections.

The first spar that we made of the box type had channel webs with flat flanges, which had only shallow corrugations, and the rivetted joint was flat. This spar was not very efficient in steel, so we deepened the corrugations and curved the rivetted joint, and this gave a better result.

The final experiment was to raise the central corrugation, and we thus have a box spar with deeply corrugated flanges and webs, the form of joint between the flanges and webs being such that one locates the other, and thus the spar is easy to assemble. The sections are easy to produce, and all the rivets are accessible. The attachment of ribs and fittings is a simple matter, and under test the spar shows a high ratio of strength to weight.

This merely indicates very roughly the steps taken in the evolution of the Wapiti spar; many other intermediate designs of box spars were made and tested whilst leading up to each stage.

At the time when these wings were designed, the method of bracing the ribs was quite novel, and was evolved after numerous experiments. It was intended to use the construction of the light ribs as a basis for all the ribs, and this has been carried out; since the compression ribs are two light ribs side by side with a wide deeply corrugated flange rivetted to them, thus making a wide rib strong enough in all directions to function as a strut; and the pulley ribs are two light ribs spaced wider apart in order to house the control gear, and connected together by channel bracing.

Close jointed and solid drawn tubes of various materials have also been tried as web bracing, but the special angle section proved strongest and lightest for this rib.

Leading and trailing edges are solid drawn tubes. The method of attaching the rib to these members is perhaps interesting, since many schemes were tried and abandoned before the present design was adopted. The rib boom is flattened where it passes round the leading edge, and a simple clip is rivetted to the flattened boom. This clip passes round the tube and is clamped on by an ordinary screw and nut. Thus by slackening the screws the clip is released and the

* Abridged.

leading edge is easily removed. Nose riblets between the light ribs are attached in a similar manner.

A somewhat similar method is used for the trailing edge. Shaped blocks to suit the rib contour are clamped to the trailing edge, and spaced at the correct distance apart, the rivets being inserted through the rib ends, the clips, and the blocks.

The strut and lift wire fittings are somewhat unusual, the design having been adopted for the sake of robustness and ease of assembly and manufacture. The principal parts are either drop forgings or pressings, and are quickly assembled by nuts and bolts.

The lift wires are attached to shackles which are bolted to two bell crank levers. The bell crank levers are attached to the spar by a central bolt. The levers are free to pivot, and so avoid introducing any offset effect when the spar is deflected under load.

The strut fork-end is mounted on a shoe plate which is bolted to the saddle-plate of the heavy rib. This shoe fitting has two extensions or lugs which carry incidence wire shackle. The design of the fitting on the spar at the root end of the wing consists of an aluminium casting, which has proved very efficient, and which, all things considered, is easy to fit. There is very little stress on it, and as designed it serves principally as a packing block.

Manufacture of Spars

With regard to the manufacture of spars, the first process is to roll the flange and webs. I am afraid there is not time to go into the rolling process in detail; it must suffice to say that the strip is passed between a number of pairs of rolls which form the section stage by stage into the finished shape, and finally overbend it in order to overcome the spring of the steel and allow it to retain its correct shape.

As the flange and web sections are rolled they are cut off to a rough length to allow for finishing. It is then inspected for straightness, correctness of section, etc.

So far flanges and webs have gone through similar processes, and now they part company until brought together again for the final assembly of the complete spar. Let us follow what happens to the flange first. This goes to the flange punching bench. Holes are punched on each side of the flange simultaneously, using a gear which can be used as fast as the operator can work, which is at the rate of less than a second for each pair of holes.

Owing to the fact that certain rivets have to be omitted so that ribs and fittings can be attached after the spar is assembled, the next operation is to place the flange alongside a pattern flange and mark these holes with a dab of paint. Then the reinforcing plates at the inner end on the crown of the spar are attached. Two tacking rivet holes are jig-drilled in the flange and the plates rivetted on. The remainder of the holes are then jig-drilled through all the plates and rivets put in. After this the flange is put into a rack until it is required for spar assembly.

The webs go through a somewhat similar process. In the centre of each web five holes are punched, one large, one medium sized, and three small ones, to allow the distance tubes at strut fittings and drag joints to pass through. These holes also prevent the tubes falling out before the fitting is assembled.

The various web plates which are ultimately rivetted to the web are then bolted in place by means of special bolts which fit the punched holes. The web plates, or where the plates are laminated, the outer plates, have the rivet

holes jig-drilled in them, and these are then transferred through the web, rivets inserted and closed up in a press. After this the tapered ends are rivetted on and the webs are then put in a rack until required.

The first operation in spar assembly proper is to take the two webs, put the necessary distance tubes between them, and bolt the whole lot together. The diaphragms are then slipped in place and located by bending the lugs over the edges of the webs. After this the flanges and webs are placed in the spar vices, and the flanges located longitudinally with respect to the webs. The spar vices are then screwed up and the holes for tacking rivets drilled at approximately 1 ft. pitch in each corner of the spar. Aluminium tacking rivets are inserted and just nobbled over by hand while the spar is held straight in the vices.

The spar can now be handled as a complete unit, and is taken to a drilling machine where the remainder of the holes are drilled 3/32 in. in diameter, the holes punched in the flanges acting as a drilling jig. As stated before, the holes in the flanges are punched less than 3/32 in. diameter. This is done for two reasons; first, because, owing to the curvature of the spar flange, the larger the hole the more tendency there is for the drill to run and so get a rivet in a position in which it is difficult to locate the head properly when closing up the rivet. Secondly, it is good practice to remove the metal surrounding a punched hole, which is done when the punched hole is opened out to the full size.

The spar is now loaded with rivets by boys, who avoid putting rivets in the holes with the white paint marks, and is taken to the rivetting presses.

The taper tubes at the ends of the spars are simply pushed in by springing open the flanges after they have been finished to length, and are secured with tubular rivets.

Now we come to the attachment of the end fitting, the aluminium casting at the inner end of the spar. This is the only fitting rivetted to the spar before the wing is assembled. This casting has two H.T.S. bearing plates attached inside, and the rough-cut ends of the spar sections have to be trimmed and fitted until they bear properly on the bearing plates when the casting is in the correct position in relation to the rest of the spar. The casting is then clamped into position and the holes for rivets attaching it to the spar are drilled, the rivets inserted, and headed over. The holes for the bolts attaching drag wiring lugs and strut fittings are then reamed to the correct size and the wiring plates at drag joints bolted on. Finally, after inspection, the spar is stove enamelled and is ready for building into a wing.

Rib Manufacture

Starting with the rib flange, the first operation is, of course, rolling the section, a fairly simple one with a plain unbeaded channel.

After cutting to length, each rib boom is bent to shape in a special bending machine. Bending section into an arc of a circle is easy, but it is a little more difficult when the required shape has a continually changing radius of curvature. Consequently, the flanges are bent to shape as nearly as possible using two or three long circular arcs. The bending is completed by hand, which allows the section to be applied to a template continually, and the shape corrected inch by inch.

The nose portion of the rib flange is treated in a somewhat different manner. A piece of channel-section of sufficient length is taken and where this will be bent round the leading edge it is flattened out. The section is then put under a press and the channel bent to the correct shape. A second press operation bends the flattened part to the correct radius and shapes it correctly where it blends into the channel section.

The flanges are then taken to the drilling jig, which is merely a board with metal blocks attached to it, the position of the blocks being such that they conform to the contour of the rib. The blocks have slots into which the flange fits, and the outside wall of the slot has a bushed hole which guides the drill, clamps are screwed down, and the holes drilled. After this the flanges are stacked until required for the final assembly of the rib.

The web section is also rolled, and after being cut to length the first operation is to flatten out or unroll the bend on the edge at points where bends will occur. This is done in a press tool, which transforms the beaded U section into a plain U section for about 3/16 in. on either side of the points where the rivet holes will come, and the flats being put in simultaneously at the correct distance apart. The bracing is now taken to another small press and the sides of the U pressed close together.

The next operation is drilling. The bracing drilling jig consists of a series of blocks just wide enough to allow the flattened out section to be inserted. The blocks have slots shaped so that the section can only be inserted when the centre of the flattened part is opposite the centre of the slot in order that the next hole may be correctly positioned along the length of the web. Like the flange drilling jig, there are bushed holes in these blocks to guide the drill.

The bending is done in another small hand-lever press which carries a rounded topped tool which fits into a hollow bottomed tool. When the top tool is forced home the section on each side of the flattened part is bent upwards by hand. The section is turned over between successive bending operations so as to form a zig-zag shape.

The various sections and saddle plates that go to make a rib are then assembled. This is done in a jig in order to ensure interchangeability. The rivet holes are then loaded with rivets and the rib finished off.

The heavy ribs are interesting in that they have gone through several stages of development which are very similar to some of the early spar development stages, but from what I have told you about the construction of light ribs, it will not be necessary to say very much about the construction of heavy ribs. The cover plates are rolled, bent and drilled by methods very similar to those employed for light rib flanges. These cover plates, light rib flanges, bracing and saddle plates are then assembled in a jig similar to that used for the light ribs and subsequent operations are also similar.

Wing Assembly

The first thing to be done is to place two spars on trestles and thread on all ribs, placing them approximately in their correct positions. Leading and trailing edges are placed in position but not secured.

This collection of parts is then taken to the assembly jigs which are vertical frames. Stops are provided to locate the spars longitudinally, and other brackets locate the ribs.

While in the jig, ribs are rivetted in position, trailing edge secured, leading edge clips tightened, and the spar clips rivetted on. Spar clips for riblets, and all rivetted-on fittings which are accessible, are also attached, and then the wing is taken out of the jig and placed flat on trestles for the first set of finishing off operations. These consist of attaching the few fittings referred to which require rivetting, such as nosing on bottom wings and door frames. The door frames for ailerons and slots are jig-drilled and hinges bolted on.

The strut fittings are assembled and drag wires put in place. The wing is trued up and castings on the spar ends adjusted to suit the interchangeability gauges, and the bolt holes put in. The wing is then put into a gas-heated oven

and "sweated" to get rid of grease and oil. After cooling it is dipped in a bath of enamel, and after draining is put back in the oven and stoved. Thus every component part of the wing has two coats of enamel stoved on.

The second set of finishing-off operations consists of fitting the fibre fair leads, wing-tip attachment, terminal blocks, various controls and electric cables, etc. Then the wing is finally trued up, and after this is ready either for despatch or covering.

It is well known that the inspection of aeroplane construction is very rigorous. In addition to the inspection before assembly of the component parts of ribs and spars, they are also inspected at intermediate stages of assembly, and, of course, after completion. The wings are inspected at each stage of assembly—first before they are removed from the vertical assembly jig; secondly, just before the stoving, and thirdly, the final inspection in skeleton before inspection by the A.I.D.

WIRELESS APPARATUS FOR AIRCRAFT

BY

C. B. CAVE

Lecture delivered before Yeovil Branch, December, 1929.

During the early stages of the development of aircraft in the pre-war days it was realised that wireless communication would provide the only satisfactory means of maintaining contact between an aeroplane and the ground. Although the technique of wireless was in its infancy at the time, it must be remembered that the needs of aviation in this respect were correspondingly limited; pilots of early types of aircraft had their time fully occupied in keeping their machines in the air at all, and had no energy to spare for communicating with persons on the ground.

From the very outset it was found that any form of visual signalling from air to ground (apart from Verey lights) was entirely impracticable, quite apart from the extremely limited range which would have been attainable: signalling from ground to air by visual means, such as ground strips, signalling lamp, Verey lights, etc., was, however, found to be more practicable, although, of course, both the range obtainable and the number of different messages which could be sent by these means were extremely limited. Furthermore, it was found that wireless communication from air to ground, which only involved the provision of transmitting apparatus in the aircraft, was a far simpler problem to solve than the reverse, which involved the reception of signals in the aircraft, and necessitated these signals being of such strength as to be readable above the noise of the engine exhaust and the propeller; in fact, wireless communication from the ground to a heavier-than-air machine was not possible until a much later stage, when the technique of wireless had made a most revolutionary advance by the evolution of the thermionic valves.

Hence, for several years wireless communication for aircraft was limited to air-to-ground communication; apparatus on the aircraft consisted of a low-power spark transmitter driven by an accumulator and operating on a trailing aerial, usually on wave-lengths of the order of 100-300 metres. Apparatus on the ground consisted of a simple crystal receiver, so that it can be imagined that the ranges obtainable were extremely limited, usually being of the order of two or three miles at most.

With the advent of the War, however, great progress was made in both the technique of aircraft design and also in that of wireless; although wireless facilities for military purposes were at first restricted to simple air-to-ground communication as already described, the advent of the thermionic valve completely revolutionised matters. First and foremost, reception of signals in the air became possible, owing to the amplification obtainable with valve amplifiers; secondly, new systems of transmission—namely, transmission by means of continuous and interrupted continuous wave telegraphy, and by means of radio telephony—became possible; and lastly, communication between aircraft themselves became possible, and ranges from ground-to-air and air-to-ground increased out of all knowledge.

The result of the enforced progress brought about under war conditions was that the techniques of aeronautics and of wireless progressed side by side; as the one advanced and so gave rise to additional requirements, so these requirements were met by corresponding progress on the part of those responsible for

aviation wireless matters. Hence that branch of wireless engineering which is special to aviation is peculiarly fortunate, inasmuch as it has been intimately bound up with the progress of aeronautics since the very early days.

After the cessation of hostilities, the use of aircraft for civil transport purposes came into being, and the specialised requirements of this form of aviation had accordingly to be met by the design of special apparatus for the purpose; in the same manner as the communications requirements for military aviation purposes increased steadily with advances of technique in aeronautics, so the communications requirements of civil aviation increased as the organisation of air routes became more and more complex. Here again those responsible for the design of apparatus suitable for the needs of civil aviation have kept in the closest touch with this latest form of aviation, with the result that at the present moment a complete range of equipment is available to meet all the needs of this form of transport.

To produce satisfactory wireless apparatus for aircraft calls for great skill on the part of the designers. On the one hand apparatus must be as light and as compact as possible; on the other hand, however, it must be extremely robust in order to withstand the vibration which is experienced, and also to stand up to the treatment to which it is usually subject under service conditions. Furthermore, and this is particularly true in the case of apparatus designed to meet the needs of civil aviation, the apparatus must be entirely safe in operation; the insulation of all components and leads must be capable of withstanding voltages well in excess of those normally used, and all feeder circuits must be adequately protected by fuses. It may be of interest to note here that the Air Ministry insists that all wireless apparatus installed in British civil aircraft shall have first been granted airworthiness approval by the Government experts; on account of the experience at the disposal of the Marconi Company, however, (as the result of many years of concentration on this class of work) the Air Ministry has agreed that any apparatus designed by the Company shall be automatically considered as approved, on the strength of a certificate issued by the Company to the effect that the apparatus as designed is safe for installation on board an aircraft.

At the present day the wireless requirements of aviation can be divided into two distinct categories, i.e., military and civil. The military requirements can be further sub-divided into the following classes:—

(*a*) Apparatus for artillery observation purposes.
(*b*) Apparatus for long distance bombing and reconnaissance purposes.
(*c*) Apparatus for flight tactical control.
(*d*) Apparatus for fleet spotting and reconnaissance.

Civil requirements can also be further sub-divided into those of the multi-seater passenger carrying aircraft which always operates over organised air routes, and those of the small (often privately owned) light aeroplane and the small "taxi" machine, which usually operate off such air routes, to which they sometimes act as "feeders."

It is not proposed to devote much time to describing in detail the requirements of military aviation, since these vary in different countries to such an extent that it is hardly possible to generalise in this respect; the policy of the air and military authorities, the size and importance of the military aviation services, and the political commitments of the various countries are some of the many factors which govern these requirements. In general, it can be said that the various requirements call for apparatus having performances as follows:—

Artillery Observation

The apparatus should provide two-way telegraphic communication between the ground and the aircraft, employing interrupted continuous wave transmission,

up to distances of about ten miles. Medium wave-lengths (of the order of 150-300 metres) are usually employed, and operation of the apparatus in the air is in some cases carried out by the pilot (the observer devoting his whole attention to the defence of the aircraft against hostile aircraft), whereas in other cases the observer undertakes this duty.

Long Distance Bombing Reconnaissance

The apparatus should provide two-way telegraphic communication between the ground and the aircraft, up to distances of about 250 miles; in order to obtain this range with the minimum weight of apparatus on the aircraft, continuous wave transmission is almost invariably employed. Operation of the apparatus in the aircraft is in all cases carried out either by a specialist W/T operator, who forms one of the crew, or by an observer specially trained in W/T duties. Long wave-lengths (of the order of 1,000-2,000 metres) are usually employed for these communications.

Flight Tactical Control

The apparatus should provide two-way telephonic communication between the ground and the formation leader's aircraft, and single-way telephonic transmission from the latter to the remaining aircraft in the formation; this involves the provision of transmission and reception apparatus in the leader's aircraft and reception apparatus alone in the remaining aircraft. As the aircraft used for this type of work are in all cases high performance single-seater fighters, the apparatus has to be as simple in operation as possible, and has to be so arranged that it can be installed in any convenient position in the aircraft and operated by remote control from the pilot's cockpit. In order not to impair the manœuvrability of the aircraft, a small aerial fixed to the aircraft is employed in place of the trailing aerial normally used for communication on the longer wave-lengths, and short wave-lengths of the order of 50-100 metres are used. The approximate distances up to which communications are usually required are 10 miles between the ground and the formation leader's aircraft, and anything up to 3 miles between aircraft.

Fleet Spotting and Reconnaissance

For this purpose, two-way telegraphic communication from ship to aircraft is required, up to a distance of about 50 miles; short wave-lengths (with fixed aerial on the aircraft) are usually employed for this purpose, although in certain cases the use of long wave-lengths is preferred. The aircraft are used for directing the fire of long-range naval guns and for reconnaissance purposes, and the apparatus on board the aircraft is in most cases operated by a specialist W/T operator or by an observer officer.

The wireless requirements of civil aviation can, as stated earlier, be roughly divided into two main categories, namely, those of the organised air services and those of the air-taxi services and privately owned light aeroplanes.

In both the above cases the reason for the provision of wireless communication is entirely different from that in the case of military aviation. In the case of organised air routes and of the taxi services the provision of wireless is essential as a means of safeguarding the lives of passengers and of assisting the air operating companies to run their services with the maximum regularity. In the case of the light aeroplanes, which do not "ply for hire or reward"—to quote the official phraseology—the question as to the safety of the general public does not arise, and the provision of wireless is accordingly not compulsory. Nevertheless, the carriage of wireless apparatus is of the greatest assistance to the pilots of such aircraft when making cross-country flights, etc.

Wireless services for organised air routes are necessarily organised on an international basis: obviously a pilot flying a passenger carrying aircraft from, say, Croydon to Basle, via Paris, does not expect to find—nor could he cope

with such an eventuality should it arise—an entirely different organisation as soon as he starts communicating with French ground stations, and yet another when he comes within range of the Swiss ground stations. Air route services are accordingly organised on a similar basis in all countries, in the same way that the services provided for the mercantile marine are international in character and in application. Furthermore, in the same manner as the wave of 600 metres has been allotted internationally as a calling and distress wave for the mercantile marine, so the wave of 900 metres has been allotted for a similar purpose for civil aircraft.

For this reason the requirements of civil passenger carrying aircraft from a wireless point of view have become more or less standardised, particularly in so far as Western Europe is concerned, where the air route wireless services are organised on an identical pattern.

On the European routes it has been found impracticable to carry a wireless operator, even on the largest passenger carrying aircraft, since the pay-load of the aircraft has to be utilised to the maximum effect in order to make the services pay their way. Furthermore, it has been found in practice that, with the unstable weather conditions encountered in Europe, direct contact between the pilot of the aircraft and the aerodrome officials is essential, in order that, for example, a quick decision may be made by the former which may make all the difference between life and death of his passengers. For these reasons, the normal practice is for telephony to be employed as a means of communication, and for the pilot himself to be a qualified telephony operator and to operate the apparatus in the aircraft; the maximum distance over which telephonic communication between the ground and the aircraft has to be maintained varies with the different routes but hardly ever exceeds one hundred and fifty miles. With the aid of his telephony apparatus, the pilot is enabled to obtain information as to the weather ahead of him, to report sudden changes of weather which he experiences in flight (such as thunderstorms or snowstorms), to obtain his position at any time from the ground direction finding organisation, to report his position from time to time to the ground authorities responsible for the control of the traffic along the routes and to be informed when other aircraft are in his vicinity when he is flying in fog or low cloud, to name only a few of the ways in which the air route wireless service is of assistance to him.

On Empire routes, however, a different state of affairs exists. Owing to the sparseness of ground organisations, including aerodrome wireless stations, two-way communication between ground and air has to be maintained up to a maximum distance, in some cases, of 250-300 miles. Owing to the fact that, for a given power, the telegraphic range (employing continuous wave transmission) of a transmitter is roughly twice the telephonic range, other conditions being equal, it has been found essential to employ the former as a means of communication. Furthermore, since it is entirely impracticable for the pilot himself to undertake telegraphic communication, the carriage of a specialist W/T operator for this purpose is essential; the fact that the volume of passenger traffic on these routes is less than on the European routes renders this essential step less distasteful to the air operating companies than would be the case had such a system been inevitable as in the case of the European routes. The advantages to be obtained by the carriage of wireless apparatus are similar to those provided in the case of the European routes, with the exception that at present no direction-finding organisation is available in the Empire routes as on the European routes.

A further point in connection with aircraft operating on Empire air routes is that arrangements are made for transmission and reception from the aircraft when on the ground—or, in the case of flying boats, when on the water—in order that, in the event of a forced landing occurring, assistance may be requested, and the aircraft maintained in communication with the nearest ground station until such time as the assistance arrives.

With regard to the wireless services for privately owned light aeroplanes, these are not yet in actual existence, and one can only hazard a forecast as to the lines on which they will develop. The light aeroplane movement is growing rapidly, and it is already apparent that the use of wireless apparatus in aircraft of this type will be of great advantage to owner pilots in their cross-country flights.

The requirements of light aeroplanes call for the most compact and the lightest possible design of telephony apparatus: in certain cases—particularly in the case of small-capacity air taxis and light aeroplanes, which may at times fly along organised air routes—two-way communication with the ground up to the maximum range possible, bearing in mind the limitations of size and weight imposed on the apparatus, is required. In other cases the provision of receiving apparatus alone in the aircraft would meet requirements, since this would enable pilots to listen-in for the radiotelephonic broadcasts of weather conditions at various centres, which it is anticipated will be provided at regular intervals throughout the day from ground stations specially erected for this purpose.

Furthermore, tests are being made at present as to the utility of single-way telephonic communication between an instructor on the ground and a pupil undertaking his first solo flight, in order to ascertain whether such a scheme would prove of real assistance in the training of pupils at a flying school or light aeroplane club.

A few words as to the aerial systems employed on aircraft may be of interest. The aerial system employed for working on long wave-lengths consists (with the one exception which will be mentioned later) of a trailing wire of about 200ft. in length (with a small lead weight at its extremity), which is unwound from a specially designed aerial winch fitted in the aircraft, and which is led out through the structure of the aircraft by means of a fairlead. The winch is so designed that an automatic centrifugal brake comes into action if the rate at which the aerial is being unwound exceeds a certain figure—as, for example, would otherwise occur if the pilot or W/T operator let go of the winch handle while unreeling the aerial—and that a ratchet mechanism comes into play when the aerial is being wound in, in order that should the pilot or operator be compelled to let go of the handle when winding in the aerial, the wire will not unreel itself again. The fairlead consists of an insulated tube through which the aerial wire passes: this tube has an internal metal sleeve or guide with which the 7-strand bare P.B. aerial wire makes contact, and connection is made between this sleeve and the apparatus in the aircraft.

Trailing aerials form the most efficient radiating and receiving systems so far as working on long wave-lengths is concerned; they are, however, admittedly a nuisance from the pilot's point of view, on account of the labour involved in winding in the length of wire, and the necessity for remembering to carry out this operation before landing or when flying low. Furthermore, from a military point of view the presence of a 200ft. length of wire trailing below the aircraft seriously impairs manœuvrability in case of attack and precludes the carrying out of aerobatics.

Fixed aerial systems are employed almost exclusively for short wave working, but in certain cases are used for long wave work. In all cases, however, such a system consists of one or a number of wires permanently fixed to and insulated from the structure of the aircraft in such a manner as to form an efficient aerial from an electrical point of view, to form an airworthy structure in itself, and, in the case of military aircraft, to cause the minimum obstruction to the field of fire from the aircraft's machine guns. The actual design of the fixed aerial depends upon the wave-length or wave-lengths which will be employed for communication purposes and upon the design of the aircraft; in general, however, bare wires of high mechanical strength are run between, and insulated from, king posts fixed to the wing tips and tail fin or rear portion of the fuselage,

and the lead-in wire brought to a lead-in insulator fixed in proximity to the actual apparatus.

For long wave work such an aerial system is admittedly inefficient, but it enables aircraft which normally employ a trailing aerial and work on long wavelengths to communicate with the ground up to short distances (20 to 30 miles) where the weather conditions are such that they are unable to employ their trailing aerials for any reason. Such a system is employed on certain of Imperial Airways aircraft, and enables these aircraft to maintain communication with the ground when, for example, they are groping their way in from the English coast to Croydon through the hills during conditions of thick fog or low cloud—conditions which often necessitate their flying too low to permit of a trailing aerial being lowered from the aircraft, and which would otherwise involve a cancelled flight or one carried out without any means of communication with ground being possible.

To talk about " earth " systems in connection with aircraft in flight sounds entirely misleading, and hence a short explanation of the function of an " earth " in a transmitting or receiving system may clear up this apparent contradiction in terms. As is well known, the simplest form of system for radiating or receiving wireless waves comprises two similar conducting wires insulated from the earth and having a high frequency oscillation generator, or, in the case of a receiving system, a means of detecting such oscillations, connected at their centre; the inductance of the wires, together with their capacity one to another, determines the frequency of the oscillations generated in the system (and hence the wavelength radiated), or, in the case of a receiving system, the frequency of the oscillations to which the system is most responsive. In the case of ground wireless stations the " aerial " as erected often comprises only one half of this fundamental radiating or receiving system; the other half is replaced by a direct electrical connection with the earth, and the frequency of oscillations generated, or alternatively, the frequency to which the system is most responsive, depends on the inductance of the aerial wires—and of any circuits coupling the transmitter or receiver to the system—and the capacity between the aerial wires and what is virtually their electrical image in the earth itself. In certain cases, however, the connection to earth is replaced by an " earth screen " or " capacity earth," which consists of a number of wires erected underneath the aerial wires at a small height above, and insulated from the earth: such a radiating or receiving system is clearly similar in principle to the simplest form of radiating or receiving systems just described. In the case of an aircraft radiating or receiving system, the whole of the metal work in the structure of the aircraft is utilised as a " capacity earth." For this purpose the aircraft is bonded, *i.e.*, all metallic components in the structure and equipment are connected together, either by means of bonding strips or wires, in the case of wooden or part metal constructed machines, or by ensuring that good electrical contact is made between all metal parts in metal constructed machines. These bonding connections must make perfect electrical contact with whatever components they connect, and must be so made from a mechanical point of view as to be proof against vibration and other stresses to which an aircraft structure is subjected. The reason for the necessity for careful and systematic bonding is two-fold; firstly, in order that the capacity of the system may be a maximum and may remain constant during flight—variations of capacity will alter the wave-length of the radiated or received waves, and will have other deleterious effects on communication such as intermittent transmission and reception, etc.—and, secondly, as a safeguard against risk of fire. In this latter event, it will be appreciated that when the radiating system is energised during transmission of signals, high frequency high-voltage oscillations are produced in it; the presence of such oscillations will induce similar high frequency oscillations in any metallic components which are insulated from the main bonding system, and the voltage of these latter oscillations may be sufficiently high to cause a spark to occur between a non-bonded and a bonded component, with a consequent risk of fire. It is therefore obvious

that in order to eliminate risk of fire from this cause the bonding of the aircraft must be as complete and as well carried out as possible, particularly where short wave work is concerned, where very high frequencies are employed.

Another question which is of vital importance to the satisfactory operation of wireless apparatus in aircraft is that of protecting the receiving apparatus from the interference produced by the engine ignition system. To appreciate the interference which will occur from this system it should be realised that each sparking plug in an internal combustion engine forms in reality a small wireless transmitter; we have the spark gap formed by the two electrodes of the plug, the capacity between these electrodes, and the inductance of the leads forming the ignition system—in fact, all the ingredients for a small spark transmitter. Every time a spark passes between the plug points a train of high frequency oscillations is set up in the ignition system, the actual frequency of the oscillations and hence the wave-length of the radiation emitted thereby, depending on the values of capacity and inductance in the circuit. With two plugs per cylinder, high speed multi-cylinder engines, and multi-engined aircraft, it can easily be seen that the interference which may be experienced from the ignition system may be of such a magnitude as completely to drown out the wanted signals, unless some action is taken to overcome the trouble.

Since the interference is caused by radiation from the ignition system which is picked up by the wireless receiving system, the obvious method of attacking the problem is either to prevent the formation of oscillations in the ignition system altogether, or to screen one system from the other by means of "earthed" metallic screens. Various methods have been proposed and many attempts made to cure the trouble by the former method, but it has been found impossible to achieve the desired result, since the first requirement of the ignition system is that it should function with the greatest possible efficiency as such, and accordingly no modifications are permissible which might cause a breakdown in the system to occur. Success has, however, been achieved by the latter method, *i.e.*, by screening one system from the other; obviously the only practicable method of carrying this out is to screen the ignition system rather than the wireless system, which comprises, amongst other parts, the aerial itself, which naturally could not be screened.

The amount of interference which is found to occur under any particular set of conditions depends on :—

(*a*) The wave-length which is employed (in general the shorter the wave-length the greater the interference);

(*b*) The sensitivity of the amplifier used in the aircraft (obviously the greater the sensitivity the greater the likely interference);

(*c*) The method of construction of the aircraft (all metal constructed aircraft are, in general, less prone to interference than other types, since bulkheads, engine cowlings, and the fuselage coverings all form natural metal screens between the ignition and wireless systems);

(*d*) The number of engines, and their position relative to the wireless apparatus and aerial system.

From the above it will be seen that the completeness or otherwise of the screening which has to be carried out on an aircraft which has to carry wireless receiving apparatus depends on a number of factors, and hence no standard specification of requirements in this respect can be laid down. From a general survey of a new type of aircraft, however, together with a knowledge of the type of receiving apparatus which is to be installed, it is usually possible to state, with a good degree of accuracy, the amount of screening which will be necessary in order to permit of satisfactory working of the wireless apparatus. Screening of the ignition system is effected by (*a*) employing an earthed metal screen to cover the distributor; (*b*) employing metal braided H.T. leads between the distributor and the plugs, and carefully earthing the braiding on to the distributor

screen at one end, and as close to the plugs as is practicable at the other; (*c*) employing earthed metal " cowls " over the plugs themselves; and (*d*) employing metal braided cables (with the braiding earthed) for starting switch leads, etc. For aircraft in which the maximum amount of screening is considered essential, all four above aids will have to be employed: for others in which less interference is anticipated the use of screened leads and distributor screens alone is enough: and in still others, where the combination of circumstances is most favourable for interference-less reception, it may not be necessary to carry out any screening other than that which is already automatically provided by metal bulkheads, engine cowlings, fuselage covering, etc.

In the past great trouble has been experienced by aircraft operating companies with the standard metal braided H.T. cable. For one thing it was found that moisture condensed, or was actually deposited, on the insulated sleeves which were provided between the plug terminals and the end of the braiding, with the result that short circuits occurred and the ignition system failed either wholly or partly. For another, corrosion of the braiding by salt water was experienced in the case of flying boats and other craft operating on the sea.

As a result, the Marconi Company have developed a new type of braided cable, which is similar to the original type but which has an external covering of tough rubber over the metal braiding. Well designed plug end fittings are provided which permit of the braiding being brought out as a " pig-tail " and earthed in proximity to the plug, without any risk of breakdown occurring due to the entry of water on to plug terminal and braiding. This improved type of cable has been tested out and found very satisfactory in practice; it has the same efficiency from a wireless point of view as the original type, but is vastly superior from an aircraft ignition point of view, and is, in addition, easier to maintain than the non-covered braided cable.

Finally, having touched upon the types of apparatus which may be installed, and on certain of the preparatory work which has to be carried out on an aircraft before the apparatus is installed, a few words on the points to be borne in mind when arranging the installation may be of interest. First and foremost, the installation of wireless apparatus *must* be considered at the same time as the installation of the remainder of the equipment; in order to provide the maximum efficiency of the wireless apparatus and to ensure that no interference between this and the remainder of the equipment occurs, this step is essential, and is best allowed for at one of the early mock-ups.

The main points to be borne in mind when arranging details of the installation of wireless apparatus are as follows:—

(*a*) Ease of operation by the pilot or W/T operator, including operation of aerial winch, if carried, as well as of controls of apparatus.

(*b*) Disposition of components so as to provide the most efficient lay-out from a wireless point of view (including protection from dampness, etc.).

(*c*) Non-interference between the wireless and other equipments. For example, interference to wireless reception may be caused by commutator ripple of wind-driven lightning generators; also, head-telephones in close proximity to compasses will cause serious errors to the latter, as will certain types of recording instruments (such as ammeters and voltmeters) which employ an electromagnet in their operation.

(*d*) Safety of the installation from an airworthiness point of view; this primarily applies in the case of civil rather than military aircraft, although obviously an installation which might be a cause of danger to the aircraft would not be passed even for military purposes. In this connection it may be of interest to note that, in so far as British-registered civil aircraft are concerned, the Air Ministry insists that the installation, as an installation, shall be approved by their technical experts before they will recommend the G.P.O. to grant a license for the aircraft wireless station.

Abridged Details of Marconi Standard Aircraft Equipments

Type	Description	Weight of Requirements	lbs.	ozs.
AD.5/12	75 watt Telephone Set ...	Transmitting and Receiving Equipment	82	.8
		Additional for Dual Control and I/C. Gear	7	3
AD.6h	150 watt general purpose Telephone-Telegraph Set	Transmitting and Receiving Equipment	104	0
		Additional for Dual Control and I/C. Gear	7	3
		Additional for Emergency Landing Gear	54	2
		Additional for Combined Wireless and Lighting Gear ...	20	12
		Additional for 33ft. Telescopic Mast	13	0
AD.6k	150 watt Telephone-Telegraph Set with 3 spot waves	Transmitting and Receiving Equipment	110	0
		Additional Gear as for Type AD.6h Set		
AD.6m	150 watt Civil Aircraft Telephone - Telegraph Set	Transmitting and Receiving Equipment	104	0
		Additional Gear as for Type AD.6h Set		
AD.7	50 watt Artillery Co-operation Set ...	Transmitting and Receiving Equipment	87	7
		Additional for Dual Control and I/C. Gear	7	3
AD.8	500 watt long range Telephone - Telegraph Set	Transmitting and Receiving Equipment	188	15
		Additional for Dual Control and I/C. Gear	7	3
		Additional for Emergency Landing Gear	48	8
		Additional for Combined Wireless and Lighting Gear ...	83	0
		Additional for 33ft. Telescopic Mast	13	0
AD.16	Marconi - Bellini - Tosi Direction Finder ...	Complete Receiving Equipment	88	12
AD.17	Marconi-Robinson Direction Finder	Complete Receiving Equipment	71	8
AD.18	250 watt Telephone-Telegraph Trans. with independent drive ...	Complete Transmitting Equipment	124	0
AD.19*	150 watt short wave Telephone - Telegraph Transmitter with independent drive ...	Complete Transmitting Equipment	68	0
AD.20*	Short wave Receiver ...	Complete Receiving Equipment	40	0
AD.21*	75 watt short wave Telegraph Transmitter ...	Complete Transmitting Equipment	52	0
AD.22	75 watt Light Plane Telephone Set ...	Complete Transmitting and Receiving Equipment	63	4

* The weights of the combined AD.19/20 and AD.21/20 sets are about 98 and 82 lbs. respectively.